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SOLUTION OF THE LLOYD-MAX QUANTIZER PARAMETERS BY THE
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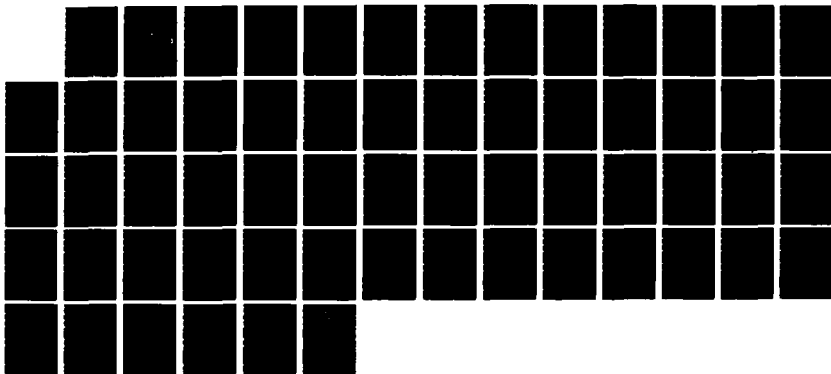
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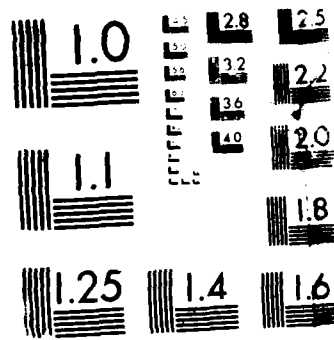
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SOLUTION OF THE LLOYD-MAX QUANTIZER PARAMETERS
BY THE METHOD OF SUCCESSIVE SUBSTITUTION

Paul H. Moose
and
A-A. M. Massiouni

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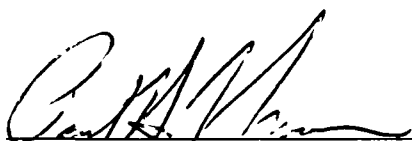
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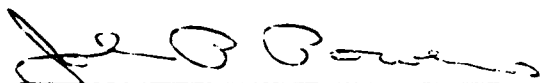


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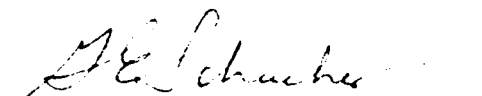
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TABLE OF CONTENTS

Abstract	1
Introduction	1
Statement of the Problem	1
Numerical Results	3
Tables	4
References	54
Distribution List	55

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SOLUTION OF THE LLOYD-MAX QUANTIZER PARAMETERS BY THE METHOD OF SUCCESSIVE SUBSTITUTION

Abstract

The method of successive substitution is shown applicable to solve for the classical minimum distortion quantizer parameters. The method is self converging and parameters can be calculated to any desired accuracy.

A. INTRODUCTION

The minimum distortion quantizer parameters [Ref. 2,1], as well as parameters based on other criterion such as quantizers for signal detection [Ref. 4], minimum risk quantizers and quantizers for LMMS estimation [Ref. 5] can be solved by Max's trial and error technique [Ref. 2]. There are also many other approximation methods to calculate the quantizer parameters [Refs. 6-8].

In this report we apply the method of successive substitution and its modifications [Ref. 3] to solve for the Lloyd-Max quantizer parameters. It is more accurate and computationally more efficient than the previously reported methods. It is shown to easily generate 7 bit (128 level) optimum quantization.

B. STATEMENT OF THE PROBLEM

The Lloyd-Max minimum mean square distortion quantizer problem deals with transforming a random variable X of differentiable probability density function $f(x)$ into the N -level discrete random variable Y .

$$Y(X) = Y_i \text{ for } X \in [x_i, x_{i+1}] \quad (\text{eqn 1.1})$$

The optimum parameters minimize the distortion D

$$D = \sum_{i=1}^N \int_{x_i}^{x_{i+1}} (x - y_i)^2 f(x) dx \quad (\text{eqn 1.2})$$

with

$$-\infty = x_1 \leq x_2 \leq \dots \leq x_N \leq x_{N+1} = \infty$$

Differentiating D with respect to x_i and y_i yields the following necessary conditions of optimality :

$$x_i = (y_i + y_{i+1})/2, i=2,3,...,N \quad (\text{eqn 1.3})$$

$$y_i = (\int_{x_i}^{x_{i+1}} xf(x)dx) / (\int_{x_i}^{x_{i+1}} f(x)dx), i=1,2,...,N \quad (\text{eqn 1.4})$$

a set of simultaneous equations of propagating character. That is, if y_1 is chosen correctly then x_2 can be calculated from (1.4), y_2 from (1.3), x_3 from (1.4) and so forth [Ref. 2]. In this case the value of y_N calculated from (1.3) must agree with its value calculated from (1.4) with $x_{N+1} = \infty$. This was the core of Max's trial and error algorithm: to pick a value for y_1 and calculate the parameters up to and including y_N , which must agree with the value of y_N calculated from (1.4), otherwise, to pick another value of y_1 . Let us put the system of equations in the form

$$\underline{Z} = \underline{G}(\underline{Z}) \quad (\text{eqn 1.5})$$

where $\underline{Z}$ is a $2N-1$ vector given by:

$$\underline{Z} = [y_1, x_2, y_2, \dots, y_N]^t \quad (\text{eqn 1.6})$$

and apply the iterative substitution

$$\underline{Z}_{\text{new}} = \underline{G}(\underline{Z}_{\text{old}}) \quad (\text{eqn 1.7})$$

with a suitable initial guess. The convergence is guaranteed if $\partial G_k / \partial Z_j$ is sufficiently small for every $k, j = 1, 2, \dots, 2N-1$ [Ref. 3]. From (1.4)

$$\partial G_j / \partial y_j = [(x_{j+1} - y_j)f(x_{j+1}) + (y_j - x_j)f(x_j)] / (2P_j) \quad (\text{eqn 1.8})$$

where P_j is the probability the input of the quantizer is in the j_{th} interval.

$$P_j = \int_{x_j}^{x_{j+1}} f(x) dx. \quad (\text{eqn 1.9})$$

The numerator in (1.8) is an approximation of the integral in (1.9) by the trapezoidal rule with the subdivision $[x_j, y_j, x_{j+1}]$, so the value of the derivative is very likely less than one. Also, substituting for y_j and y_{j+1} in (1.3) from (1.4) and differentiating with respect to x_j it is easily to show that

$$\partial G_j / \partial x_j = (y_j - x_j) f(x_j) / (2P_j) + (x_j - y_{j-1}) f(x_j) / 2P_{j-1} \quad (\text{eqn 1.10})$$

which is less than $(\partial G_j / \partial y_j)$. The method can be more efficient if we use the updated values in the same iteration. In this modification of the method the best current values of the parameters are used. This choice may also enhance convergence. The method also avoids the tedious calculation of the upper limit of the integral to solve for the next x_j in (1.4). A FORTRAN program is included as Appendix A.

C. NUMERICAL RESULTS.

We have solved for the quantizer parameters for a standard normal random variable of zero mean and unit variance for values of N up to 128. Also the mean square error D and the output entropy $(-\sum_k P_k \log_2(P_k))$ have been calculated. The results presented in Table 1 show that in several cases Max's results, which were only available up to $N=36$, are not accurate in the last digit.

Key to Table 1

The numbering in the table is as follows:

1. For N even, each table begins with the $(N/2 + 1)_{th}$ parameters. In this case the $(N/2 + 1)_{th}$ value of x is zero.
2. For N odd, each table begins with the $(N/2 + 2)_{th}$ parameters. In this case the $(N/2 + 2)_{th}$ value of y is zero.

Negative parameters can be calculated from the symmetry relations

$$X_j = -X_{n-j+2} \quad (\text{eqn 1.11})$$

and

$$y_j = -y_{n-j+1}. \quad (\text{eqn 1.12})$$

TABLE 1
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION

N = 2			N = 8		
J	X	Y	J	X	Y
2	0.000000	0.797885	5	0.000000	0.245094
ERROR =		0.363380	6	0.500530	0.756005
ENTROPY =		1.000000	7	1.049957	1.343909
=====			8	1.747927	2.151946
N = 3			ERROR = 0.034548		
J	X	Y	ENTROPY = 2.824865		
2	-0.612003	0.000000	=====		
3	0.612003	1.224006	N = 9		
ERROR =		0.190174	J	X	Y
ENTROPY =		1.535789	5	-0.221819	0.000000
=====			6	0.221819	0.443639
N = 4			7	0.681217	0.918796
J	X	Y	8	1.197594	1.476392
3	0.000000	0.452780	9	1.865528	2.254664
4	0.981599	1.510418	ERROR =		0.027853
ERROR =		0.117482	ENTROPY =		2.982695
ENTROPY =		1.911099	=====		
=====			N = 10		
N = 5			J	X	Y
J	X	Y	6	0.000000	0.199623
3	-0.382284	0.000000	7	0.404740	0.609857
4	0.382284	0.764567	8	0.833841	1.057825
5	1.244357	1.724147	9	1.324583	1.591340
ERROR =		0.079941	10	1.968218	2.345096
ENTROPY =		2.202916	ERROR =		0.022937
=====			ENTROPY =		3.124584
N = 6			=====		
J	X	Y	N = 11		
4	0.000000	0.317716	J	X	Y
5	0.658911	1.000106	6	-0.183729	0.000000
6	1.446850	1.893595	7	0.183729	0.367458
ERROR =		0.057978	8	0.559913	0.752367
ENTROPY =		2.442789	9	0.965597	1.178826
=====			10	1.435733	1.692639
N = 7			11	2.059193	2.425746
J	X	Y	ERROR =		0.019220
4	-0.280289	0.000000	ENTROPY =		3.253506
5	0.280288	0.560577	=====		
6	0.874362	1.188147	N = 12		
7	1.610758	2.033369	J	X	Y
ERROR =		0.044000	7	0.000000	0.168438
ENTROPY =		2.646931	8	0.340142	0.511846
=====			9	0.694313	0.876779
			10	1.081245	1.285711
			11	1.534371	1.783030
			12	2.140733	2.498435
			ERROR =		0.016340
			ENTROPY =		3.371666
			=====		

TABLE I
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 13			N = 17		
J	X	Y	J	X	Y
7	-0.156887	0.000000	9	-0.121497	0.000000
8	0.156887	0.313773	10	0.121497	0.242994
9	0.476012	0.638251	11	0.366938	0.490882
10	0.812600	0.986949	12	0.620085	0.749287
11	1.184106	1.381263	13	0.887442	1.025597
12	1.622890	1.864518	14	1.178246	1.330896
13	2.214522	2.564525	15	1.507669	1.684442
ERROR =		0.014063	16	1.905707	2.126971
ENTROPY =		3.480744	17	2.453866	2.780762
=====			=====		
N = 14			N = 18		
J	X	Y	J	X	Y
8	0.000000	0.145706	10	0.000000	0.114769
9	0.293513	0.441321	11	0.230557	0.346345
10	0.595882	0.750443	12	0.465324	0.584302
11	0.918039	1.085635	13	0.709082	0.833862
12	1.276582	1.467528	14	0.967981	1.102100
13	1.703070	1.938612	15	1.250963	1.399827
14	2.281837	2.625062	16	1.572915	1.746003
ERROR =		0.012232	17	1.963465	2.180927
ENTROPY =		3.582050	18	2.503372	2.825817
=====			=====		
N = 15			N = 19		
J	X	Y	J	X	Y
8	-0.136929	0.000000	10	-0.109205	0.000000
9	0.136928	0.273857	11	0.109204	0.218409
10	0.414310	0.554764	12	0.329382	0.440355
11	0.702949	0.851134	13	0.555076	0.669797
12	1.013007	1.174879	14	0.790731	0.911666
13	1.360468	1.546057	15	1.042234	1.172801
14	1.776266	2.006474	16	1.318296	1.463791
15	2.343670	2.680866	17	1.633568	1.803345
ERROR =		0.010737	18	2.017359	2.231373
ENTROPY =		3.676630	19	2.549745	2.868116
=====			=====		
N = 16			N = 20		
J	X	Y	J	X	Y
9	0.000000	0.128395	10	0.000000	0.000000
10	0.258222	0.388048	11	0.109204	0.218409
11	0.522404	0.656759	12	0.329382	0.440355
12	0.799530	0.942340	13	0.555076	0.669797
13	1.099286	1.256231	14	0.790731	0.911666
14	1.437139	1.618046	15	1.042234	1.172801
15	1.843532	2.069017	16	1.318296	1.463791
16	2.400803	2.732590	17	1.633568	1.803345
ERROR =		0.009501	18	2.017359	2.231373
ENTROPY =		3.765328	19	2.549745	2.868116
=====			=====		
N = 21			N = 22		
J	X	Y	J	X	Y
10	0.000000	0.000000	10	0.000000	0.000000
11	0.258222	0.388048	11	0.109204	0.218409
12	0.522404	0.656759	12	0.329382	0.440355
13	0.799530	0.942340	13	0.555076	0.669797
14	1.099286	1.256231	14	0.790731	0.911666
15	1.437139	1.618046	15	1.042234	1.172801
16	1.843532	2.069017	16	1.318296	1.463791
17	2.400803	2.732590	17	1.633568	1.803345
ERROR =		0.008467	18	2.017359	2.231373
ENTROPY =		3.848840	19	2.549745	2.868116
=====			=====		

TABLE 1
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 20		
J	X	Y
11	0.000000	0.103762
12	0.208277	0.312791
13	0.419640	0.526488
14	0.637511	0.748533
15	0.866088	0.983642
16	1.111055	1.238467
17	1.380941	1.523414
18	1.690196	1.856977
19	2.067846	2.278714
20	2.593337	2.907961

ERROR =		0.006208
ENTROPY =		4.073583
=====		
N = 21		
J	X	Y
11	-0.099179	0.000000
12	0.099178	0.198357
13	0.298856	0.399355
14	0.502624	0.605892
15	0.713667	0.821412
16	0.935997	1.050552
17	1.175138	1.299725
18	1.439169	1.579214
19	1.743269	1.907323
20	2.115306	2.323289
21	2.634440	2.945607

ERROR =		0.005653
ENTROPY =		4.141290
=====		
N = 22		
J	X	Y
12	0.000000	0.094686
13	0.189942	0.285198
14	0.382215	0.479232
15	0.579359	0.679485
16	0.784380	0.889276
17	1.001147	1.113019
18	1.235056	1.357093
19	1.494358	1.631622
20	1.793180	1.954739
21	2.160062	2.365386
22	2.673330	2.981274

ERROR =		0.005170
ENTROPY =		4.205942
=====		

N = 23		
J	X	Y
12	-0.090844	0.000000
13	0.090844	0.181688
14	0.273544	0.365400
15	0.459363	0.553325
16	0.650668	0.748012
17	0.850333	0.952654
18	1.062107	1.171561
19	1.291284	1.411007
20	1.546005	1.681003
21	1.840265	1.999527
22	2.202390	2.405252
23	2.710201	3.015150

ERROR =		0.004746
ENTROPY =		4.267806
=====		
N = 24		
J	X	Y
13	0.000000	0.087072
14	0.174587	0.262101
15	0.350977	0.439853
16	0.531112	0.622370
17	0.717227	0.812084
18	0.912088	1.012091
19	1.119352	1.226612
20	1.341223	1.461934
21	1.594750	1.727666
22	1.884807	2.041948
23	2.242523	2.443098
24	2.745248	3.047398

ERROR =		0.004372
ENTROPY =		4.327112
=====		
N = 25		
J	X	Y
13	-0.083805	0.000000
14	0.083805	0.167610
15	0.252208	0.336806
16	0.423045	0.509283
17	0.598128	0.686972
18	0.779592	0.872212
19	0.970115	1.068019
20	1.173279	1.278540
21	1.394213	1.509886
22	1.640881	1.771876
23	1.927050	2.082224
24	2.280667	2.479110
25	2.778634	3.078159

ERROR =		0.004041
ENTROPY =		4.384064
=====		

TABLE I
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 26		
J	X	Y
14	0.000000	0.080593
15	0.161536	0.242480
16	0.324498	0.406516
17	0.490402	0.574288
18	0.660961	0.747635
19	0.838229	0.928823
20	1.024813	1.120803
21	1.224230	1.322765
22	1.441544	1.555432
23	1.684648	1.813865
24	1.967207	2.120549
25	2.316997	2.513445
26	2.810502	3.107559
=====		
ERROR =		0.003746
ENTROPY =		4.438843
=====		

N = 27		
J	X	Y
14	-0.077781	0.000000
15	0.077780	0.155561
16	0.233975	0.312389
17	0.392106	0.471823
18	0.553594	0.633564
19	0.720073	0.804782
20	0.893532	0.982281
21	1.076318	1.170756
22	1.272495	1.374235
23	1.486469	1.598704
24	1.726267	1.853829
25	2.005461	2.157093
26	2.351670	2.546247
27	2.840977	3.135707
=====		
ERROR =		0.003483
ENTROPY =		4.491610
=====		

N = 28		
J	X	Y
15	0.000000	0.075012
16	0.150307	0.225602
17	0.301760	0.377919
18	0.455569	0.533219
19	0.613076	0.692934
20	0.775854	0.858775
21	0.945836	1.032897
22	1.125522	1.218147
23	1.318326	1.418505
24	1.529205	1.639905
25	1.765925	1.891945
26	2.041975	2.192005
27	2.384821	2.577637
28	2.870169	3.162701
=====		
ERROR =		0.003246
ENTROPY =		4.542507
=====		

N = 29		
J	X	Y
15	-0.072566	0.000000
16	0.072566	0.145132
17	0.218211	0.291291
18	0.365424	0.439557
19	0.515338	0.591119
20	0.669236	0.747352
21	0.828638	0.909923
22	0.995431	1.080939
23	1.172074	1.263209
24	1.361940	1.460671
25	1.569941	1.679211
26	1.803788	1.928364
27	2.076890	2.225415
28	2.416571	2.607727
29	2.898177	3.188627
=====		
ERROR =		0.003032
ENTROPY =		4.591663
=====		

N = 30		
J	X	Y
16	0.000000	0.071055
17	0.140542	0.217091
18	0.282012	0.365990
19	0.425519	0.519040
20	0.571953	0.678416
21	0.722240	0.845090
22	0.878709	1.020000
23	1.042565	1.203400
24	1.216393	1.396147
25	1.400353	1.599912
26	1.608846	1.826499
27	1.840001	2.077999
28	2.110332	2.356344
29	2.417027	2.663664
30	2.925088	3.213562
=====		
ERROR =		0.002839
ENTROPY =		4.639193
=====		

TABLE 1
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 31		
J	X	Y
16	0.00680008	0.00000000
17	0.00680008	0.01360016
18	0.02044466	0.02728766
19	0.34211770	0.04111464
20	0.48211011	0.05527399
21	0.62252677	0.06977994
22	0.77285888	0.08477221
23	0.92263333	0.10004771
24	1.08279511	0.11570200
25	1.25286644	0.13163388
26	1.43293333	0.14793855
27	1.62299555	0.16464433
28	1.82306666	0.18175511
29	2.03313333	0.19926644
30	2.25320000	0.21717777
ENTROPY =		0.002664
MAXIMUM PROPY =		4.685201

N = 32		
J	X	Y
17	0.00000000	0.065890
18	0.13131977	0.198052
19	0.26263954	0.333333
20	0.39395931	0.466666
21	0.52527908	0.600000
22	0.65659885	0.733333
23	0.78791862	0.866666
24	0.91923839	1.000000
25	1.05055816	1.133333
26	1.18187793	1.266666
27	1.31319770	1.400000
28	1.44451747	1.533333
29	1.57583724	1.666666
30	1.70715701	1.800000
31	1.83847678	1.933333
32	1.96979655	2.066666
ENTROPY =		0.002505
MAXIMUM PROPY =		4.729784

N = 33		
J	X	Y
17	0.06339900	0.00000000
18	0.06339900	0.122790
19	0.19233200	0.255667
20	0.32117719	0.388544
21	0.45002238	0.521421
22	0.57886757	0.654298
23	0.70771276	0.787175
24	0.83655795	0.920052
25	0.96540314	1.052929
26	1.09424833	1.185806
27	1.22309352	1.318683
28	1.35193871	1.451560
29	1.48078390	1.584437
30	1.60962909	1.717314
31	1.73847428	1.850191
32	1.86731947	1.983068
33	1.99616466	2.115945
ENTROPY =		0.002339
MAXIMUM PROPY =		4.776025

N = 34		
J	X	Y
18	0.00000000	0.0662113
19	0.1244387	0.186666
20	0.2488774	0.307143
21	0.3733161	0.427619
22	0.4977548	0.548095
23	0.6221935	0.668571
24	0.7466322	0.789048
25	0.8710709	0.909524
26	0.9955096	1.029999
27	1.1199483	1.150475
28	1.2443870	1.270951
29	1.3688257	1.391427
30	1.4932644	1.511903
31	1.6177031	1.632379
32	1.7421418	1.752855
33	1.8665805	1.873331
34	1.9910192	1.993807
ENTROPY =		0.002226
MAXIMUM PROPY =		4.815004

TABLE 1
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 35			N = 37		
J	X	Y	J	X	Y
18	-0.060420	0.000000	19	-0.057229	0.000000
19	0.060420	0.120840	20	0.057228	0.114457
20	0.181556	0.242272	21	0.171937	0.229416
21	0.303590	0.364907	22	0.287406	0.345396
22	0.427154	0.489401	23	0.404171	0.462946
23	0.552939	0.616478	24	0.522808	0.582670
24	0.681721	0.746965	25	0.643958	0.705246
25	0.814402	0.881839	26	0.768354	0.831462
26	0.952063	1.022287	27	0.896860	0.962258
27	1.096045	1.169804	28	1.030524	1.098789
28	1.248071	1.326339	29	1.170652	1.242515
29	1.410437	1.494535	30	1.318934	1.395353
30	1.586344	1.678153	31	1.477631	1.559910
31	1.780507	1.882861	32	1.649906	1.733903
32	2.000379	2.117898	33	1.840425	1.940946
33	2.258981	2.400065	34	2.056573	2.172199
34	2.582918	2.765771	35	2.311265	2.450331
35	3.045679	3.325587	36	2.630905	2.811480
			37	3.088458	3.365436
ERROR = 0.002104			ERROR = 0.001888		
ENTROPY = 4.855793			ENTROPY = 4.934058		
N = 36			N = 38		
J	X	Y	J	X	Y
19	0.000000	0.058747	20	0.000000	0.055727
20	0.117630	0.176512	21	0.111570	0.167413
21	0.235806	0.295100	22	0.223606	0.279799
22	0.355094	0.415088	23	0.336588	0.393377
23	0.476096	0.537104	24	0.451025	0.508673
24	0.599475	0.661847	25	0.567472	0.626270
25	0.725985	0.790123	26	0.686549	0.746829
26	0.856506	0.922889	27	0.808975	0.871121
27	0.992102	1.061131	28	0.935596	1.000071
28	1.134096	1.206878	29	1.067445	1.134820
29	1.284194	1.361509	30	1.205818	1.276815
30	1.444672	1.527835	31	1.352387	1.427953
31	1.618713	1.709591	32	1.509400	1.590841
32	1.811006	1.912420	33	1.680000	1.769160
33	2.028969	2.145518	34	1.868833	1.968505
34	2.285569	2.425621	35	2.083252	2.197998
35	2.607309	2.788998	36	2.336122	2.474247
36	3.067411	3.345823	37	2.653754	2.833261
			38	3.108861	3.384461
ERROR = 0.001991			ERROR = 0.001792		
ENTROPY = 4.895457			ENTROPY = 4.971649		

TABLE 1
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 39		
J	X	Y
20	-0.054358	0.000000
21	0.054357	0.108715
22	0.163288	0.217860
23	0.272286	0.327878
24	0.383557	0.439236
25	0.495583	0.552440
26	0.610249	0.668057
27	0.727394	0.786731
28	0.847976	0.909220
29	0.972282	1.036437
30	1.102972	1.169508
31	1.239688	1.309869
32	1.384633	1.459408
33	1.540055	1.620702
34	1.709065	1.797429
35	1.899622	1.995157
36	2.109062	2.222968
37	2.360199	2.497415
38	2.675899	2.854381
39	3.128656	3.402931
ERROR = 0.001703		
ENTROPY = 5.008284		

N = 40		
J	X	Y
21	0.000000	0.053003
22	0.106105	0.159207
23	0.212610	0.266014
24	0.319929	0.373842
25	0.428491	0.483140
26	0.538769	0.594398
27	0.651282	0.708166
28	0.766620	0.825075
29	0.885473	0.945871
30	1.008663	1.071455
31	1.137199	1.202942
32	1.272350	1.341175
33	1.415766	1.489775
34	1.569667	1.644953
35	1.737165	1.824771
36	1.922862	2.020954
37	2.134096	2.247159
38	2.383518	2.519877
39	2.697377	2.874878
40	3.147876	3.420875
ERROR = 0.001621		
ENTROPY = 5.044010		

N = 41		
J	X	Y
21	-0.051761	0.000000
22	0.051761	0.103522
23	0.155469	0.207416
24	0.259739	0.312062
25	0.364961	0.417860
26	0.471551	0.525241
27	0.579961	0.634681
28	0.690699	0.746717
29	0.804344	0.861970
30	0.921571	0.981172
31	1.043194	1.105216
32	1.170210	1.235205
33	1.303888	1.372554
34	1.444584	1.519128
35	1.593801	1.677747
36	1.764357	1.851240
37	1.948594	2.045947
38	2.158280	2.270613
39	2.406144	2.541674
40	2.718229	2.894784
41	3.166553	3.438322
ERROR = 0.001545		
ENTROPY = 5.078870		

N = 42		
J	X	Y
22	0.000000	0.050532
23	0.101151	0.151770
24	0.202649	0.253528
25	0.304849	0.356170
26	0.408125	0.460079
27	0.512875	0.565671
28	0.619541	0.673410
29	0.728616	0.783821
30	0.840668	0.897514
31	0.956364	1.015213
32	1.076507	1.137800
33	1.202085	1.266370
34	1.334349	1.402327
35	1.474926	1.547526
36	1.626014	1.704502
37	1.790695	1.876867
38	1.973535	2.070182
39	2.181777	2.293372
40	2.428107	2.562841
41	2.738486	2.914131
42	3.184714	3.455297
ERROR = 0.001474		
ENTROPY = 5.112906		

TABLE 1
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 43		
J	X	Y
22	-0.049402	0.000000
23	0.049402	0.098804
24	0.148367	0.197930
25	0.247820	0.297709
26	0.348098	0.398487
27	0.449560	0.500632
28	0.552591	0.604551
29	0.657622	0.710693
30	0.765133	0.819574
31	0.875685	0.931797
32	0.989936	1.048075
33	1.108678	1.169281
34	1.232893	1.296504
35	1.363821	1.431138
36	1.503082	1.575026
37	1.652860	1.730694
38	1.816226	1.901759
39	1.999772	2.093700
40	2.204587	2.315474
41	2.449443	2.583412
42	2.758180	2.932948
43	3.202386	3.471824
=====		
ERROR =		0.001407
ENTROPY =		5.146156
=====		

N = 44		
J	X	Y
23	0.000000	0.048282
24	0.096640	0.144997
25	0.193582	0.242167
26	0.291136	0.340105
27	0.389624	0.439143
28	0.488939	0.539639
29	0.590812	0.641986
30	0.694306	0.746626
31	0.800346	0.854066
32	0.909482	0.964898
33	1.022364	1.079830
34	1.139779	1.199727
35	1.262693	1.325669
36	1.392355	1.459041
37	1.530360	1.601679
38	1.678888	1.756097
39	1.840997	1.925897
40	2.021218	2.116539
41	2.226746	2.336952
42	2.470185	2.603417
43	2.777339	2.951262
44	3.219593	3.487924
=====		
ERROR =		0.001345
ENTROPY =		5.178655
=====		

N = 45		
J	X	Y
23	-0.047248	0.000000
24	0.047248	0.094497
25	0.141886	0.189276
26	0.236950	0.284625
27	0.332735	0.380845
28	0.429551	0.478256
29	0.527730	0.577204
30	0.627639	0.678074
31	0.729686	0.781298
32	0.834337	0.887375
33	0.942134	0.996892
34	1.053719	1.110547
35	1.169873	1.229199
36	1.291560	1.353920
37	1.420005	1.486090
38	1.556811	1.627533
39	1.704143	1.780753
40	1.865047	1.949341
41	2.044038	2.138736
42	2.248288	2.357840
43	2.490362	2.622884
44	2.795991	2.969098
45	3.236358	3.503619
=====		
ERROR =		0.001287
ENTROPY =		5.210437
=====		

N = 46		
J	X	Y
24	0.000000	0.046224
25	0.092514	0.138804
26	0.185294	0.231783
27	0.278609	0.325435
28	0.372741	0.420048
29	0.467990	0.515932
30	0.564679	0.613425
31	0.663163	0.712902
32	0.763845	0.814788
33	0.867192	0.919576
34	0.973710	1.027844
35	1.084065	1.140286
36	1.199020	1.257753
37	1.319532	1.381311
38	1.446821	1.512331
39	1.582481	1.652630
40	1.728667	1.804704
41	1.888415	1.972127
42	2.066225	2.160324
43	2.269245	2.378167
44	2.510004	2.641842
45	2.814160	2.986478
46	3.252702	3.518926
=====		
ERROR =		0.001233
ENTROPY =		5.241533
=====		

TABLE 1
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION

N = 47			N = 49		
J	X	Y	J	X	Y
24	-0.045275	0.000000	25	-0.043460	0.000000
25	0.045275	0.090550	26	0.043460	0.086920
26	0.135949	0.181348	27	0.130490	0.174059
27	0.226998	0.272648	28	0.217851	0.261642
28	0.318680	0.364712	29	0.305770	0.349899
29	0.411265	0.457818	30	0.394487	0.439074
30	0.505042	0.552267	31	0.484252	0.529429
31	0.600327	0.648388	32	0.575339	0.621249
32	0.697469	0.746549	33	0.668049	0.714849
33	0.796860	0.847170	34	0.762718	0.810586
34	0.898953	0.950735	35	0.859726	0.908866
35	1.004276	1.057817	36	0.959515	1.010164
36	1.113461	1.169104	37	1.062603	1.115042
37	1.227273	1.285441	38	1.169610	1.224177
38	1.346664	1.407887	39	1.281291	1.338404
39	1.472848	1.537808	40	1.398587	1.458770
40	1.607410	1.677012	41	1.522699	1.586628
41	1.752498	1.827984	42	1.655200	1.723772
42	1.911136	1.994289	43	1.798221	1.872670
43	2.087810	2.181332	44	1.954766	2.036862
44	2.289646	2.397960	45	2.129292	2.221723
45	2.529136	2.660313	46	2.328885	2.436047
46	2.831868	3.003424	47	2.565967	2.695886
47	3.268645	3.533865	48	2.865990	3.036093
			49	3.299397	3.562701
ERROR = 0.001192			ERROR = 0.001089		
ENTROPY = 5.271972			ENTROPY = 5.330984		
N = 48			N = 50		
J	X	Y	J	X	Y
25	0.000000	0.044334	26	0.000000	0.042593
26	0.088727	0.133119	27	0.085238	0.127883
27	0.177688	0.222256	28	0.170683	0.213483
28	0.267121	0.311985	29	0.256546	0.299609
29	0.357273	0.402560	30	0.343046	0.386482
30	0.448405	0.494250	31	0.430411	0.474339
31	0.540798	0.587346	32	0.518887	0.563434
32	0.634759	0.682172	33	0.608740	0.654046
33	0.730630	0.779089	34	0.700265	0.746485
34	0.828799	0.878509	35	0.793793	0.841101
35	0.929711	0.980913	36	0.889699	0.938297
36	1.033889	1.086866	37	0.988420	1.038542
37	1.141959	1.197052	38	1.090468	1.142393
38	1.254681	1.312310	39	1.196459	1.250524
39	1.373002	1.433693	40	1.307144	1.363763
40	1.498127	1.562561	41	1.423458	1.483154
41	1.631638	1.700715	42	1.546598	1.610042
42	1.775672	1.850629	43	1.678130	1.746217
43	1.933243	2.015857	44	1.820177	1.894136
44	2.108823	2.201789	45	1.975733	2.057330
45	2.309518	2.417246	46	2.149243	2.241156
46	2.547783	2.678320	47	2.347771	2.454386
47	2.849138	3.019956	48	2.583709	2.713031
48	3.284204	3.548451	49	2.882442	3.051853
			50	3.314240	3.576627
ERROR = 0.001134			ERROR = 0.001047		
ENTROPY = 5.301780			ENTROPY = 5.359608		

TABLE 1
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 51			N = 52		
J	X	Y	J	X	Y
26	-0.041785	0.000000	27	0.000000	0.040984
27	0.041785	0.083570	28	0.082013	0.123043
28	0.125453	0.167335	29	0.164211	0.205379
29	0.209414	0.251494	30	0.246781	0.288182
30	0.293872	0.336250	31	0.329916	0.371650
31	0.379035	0.421820	32	0.413820	0.455989
32	0.465126	0.508433	33	0.498707	0.541425
33	0.552384	0.596336	34	0.584812	0.628199
34	0.641069	0.685803	35	0.672389	0.716579
35	0.731471	0.777139	36	0.761723	0.806867
36	0.823914	0.870690	37	0.853135	0.899402
37	0.918771	0.966852	38	0.946991	0.994580
38	1.016473	1.066093	39	1.043720	1.092860
39	1.117528	1.168963	40	1.143826	1.194792
40	1.222548	1.276133	41	1.247916	1.301040
41	1.332279	1.388425	42	1.356732	1.412425
42	1.447652	1.506880	43	1.471202	1.529980
43	1.569858	1.632837	44	1.592511	1.655042
44	1.700438	1.768079	45	1.722213	1.789384
45	1.841567	1.915055	46	1.862418	1.935451
46	1.996170	2.077285	47	2.016101	2.096751
47	2.168698	2.260112	48	2.187682	2.278613
48	2.366199	2.472285	49	2.384188	2.489762
49	2.601028	2.729772	50	2.617944	2.746127
50	2.898511	3.067251	51	2.914215	3.082303
51	3.328748	3.590245	52	3.342935	3.603567
ERROR = 0.001007			ERROR = 0.000969		
ENTROPY = 5.387674			ENTROPY = 5.415203		

TABLE I
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 53			N = 54		
J	X	Y	J	X	Y
27	0.0402335	0.0000000	28	0.0000000	0.039491
28	0.0402334	0.0080469	29	0.0790224	0.1185556
29	0.1207900	0.1611112	30	0.1582113	0.1978669
30	0.2016009	0.2421066	31	0.2377334	0.2775999
31	0.2828699	0.3236333	32	0.3177600	0.3579222
32	0.3647588	0.4058884	33	0.3984772	0.4390222
33	0.447472	0.4890600	34	0.4800599	0.5210997
34	0.5312220	0.5733381	35	0.5627228	0.6043559
35	0.6162332	0.6590833	36	0.6467000	0.6890422
36	0.7027566	0.7464300	37	0.7322224	0.7754055
37	0.791074	0.8357199	38	0.8195744	0.8637422
38	0.8815002	0.9272886	39	0.9090663	0.9543884
39	0.974404	1.0215222	40	1.0010552	1.0477720
40	1.0702003	1.1188884	41	1.0959961	1.1442202
41	1.1694000	1.219917	42	1.1942887	1.2244373
42	1.2725999	1.3252881	43	1.2966631	1.3488889
43	1.3805388	1.4357994	44	1.4037226	1.4585664
44	1.4941400	1.5524885	45	1.516493	1.5744222
45	1.6145884	1.6766884	46	1.6361055	1.6977899
46	1.7434222	1.8101600	47	1.764109	1.8304300
47	1.8827555	1.955349	48	1.9026001	1.974772
48	2.0355500	2.115751	49	2.0545338	2.134304
49	2.206215	2.296678	50	2.2243155	2.3143227
50	2.401757	2.506836	51	2.418925	2.523524
51	2.634474	2.762113	52	2.650634	2.777745
52	2.929568	3.097023	53	2.944585	3.111426
53	3.356814	3.616605	54	3.370398	3.629370
ERROR = 0.000934			ERROR = 0.000900		
ENTROPY = 5.442216			ENTROPY = 5.468732		

TABLE I
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 55			N = 56		
J	X	Y	J	X	Y
28	-0.038795	0.000000	29	0.000000	0.038104
29	0.038795	0.077590	30	0.076245	0.114386
30	0.116463	0.155336	31	0.152633	0.190890
31	0.194366	0.233396	32	0.229933	0.267769
32	0.272665	0.311193	33	0.306447	0.345179
33	0.351526	0.391111	34	0.384232	0.423328
34	0.431123	0.471112	35	0.462277	0.502266
35	0.511123	0.552115	36	0.542227	0.582239
36	0.593322	0.634411	37	0.622299	0.663355
37	0.676627	0.718111	38	0.700498	0.746383
38	0.760839	0.803552	39	0.788648	0.833091
39	0.844726	0.890097	40	0.877411	0.921770
40	0.933585	0.980737	41	0.966222	1.000000
41	1.026974	1.073221	42	1.055211	1.093802
42	1.121103	1.168849	43	1.144443	1.192857
43	1.216100	1.266881	44	1.234221	1.291140
44	1.312004	1.371893	45	1.324286	1.394321
45	1.408632	1.480761	46	1.414883	1.502411
46	1.505389	1.595817	47	1.505953	1.616694
47	1.603709	1.718382	48	1.597590	1.738486
48	1.704227	1.850226	49	1.680413	1.869533
49	1.807977	1.993373	50	1.764904	2.012269
50	1.921084	2.152429	51	1.851207	2.170146
51	2.044203	2.333157	52	1.939995	2.348444
52	2.177009	2.539841	53	2.032244	2.555804
53	2.319999	2.793037	54	2.129044	2.808004
54	2.473800	3.125523	55	2.233665	3.139327
55	2.638998	3.641873	56	2.396725	3.654124
ERROR = 0.000868			ERROR = 0.000838		
ENTROPY = 5.494769			ENTROPY = 5.520344		

TABLE 1
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 57			N = 58		
J	X	Y	J	X	Y
29	0.037455	0.000000	30	0.000000	0.036811
30	0.037455	0.074910	31	0.073655	0.110499
31	0.112435	0.149960	32	0.147443	0.184388
32	0.187627	0.225293	33	0.221501	0.258614
33	0.263174	0.301055	34	0.295966	0.333318
34	0.339226	0.377398	35	0.370983	0.408647
35	0.415939	0.454480	36	0.446703	0.484758
36	0.493477	0.532474	37	0.523288	0.561817
37	0.572019	0.611564	38	0.600091	0.640004
38	0.651756	0.691949	39	0.677976	0.719519
39	0.733302	0.773854	40	0.760049	0.800579
40	0.815691	0.857527	41	0.842200	0.883433
41	0.900039	0.943252	42	0.925896	0.968859
42	0.987730	1.031352	43	1.012020	1.055681
43	1.076779	1.122205	44	1.100726	1.145772
44	1.169233	1.216257	45	1.192423	1.239907
45	1.265514	1.314039	46	1.287597	1.336120
46	1.365937	1.415999	47	1.386836	1.437552
47	1.469900	1.523354	48	1.490086	1.544411
48	1.577000	1.637077	49	1.600579	1.655683
49	1.689339	1.758121	50	1.717147	1.777330
50	1.802220	1.888420	51	1.842092	1.906876
51	1.959440	2.030382	52	1.977486	2.048095
52	2.108926	2.187470	53	2.126256	2.204417
53	2.276207	2.364944	54	2.292755	2.381092
54	2.463835	2.571426	55	2.483906	2.588720
55	2.669704	2.822658	56	2.711865	2.837011
56	2.987756	3.152948	57	3.001555	3.166099
57	3.409491	3.666133	58	3.422003	3.677908
ERROR = 0.000809			ERROR = 0.000782		
ENTROPY = 5.545472			ENTROPY = 5.570170		

TABLE 1
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 59			N = 60		
J	X	Y	J	X	Y
30	0.036205	0.000000	31	0.000000	0.035602
31	0.036204	0.007240	32	0.071233	0.106868
32	0.108677	0.144945	33	0.142591	0.178315
33	0.181340	0.217736	34	0.214191	0.250066
34	0.254325	0.290914	35	0.286158	0.322250
35	0.327764	0.364614	36	0.358624	0.394997
36	0.401179	0.438982	37	0.431723	0.468449
37	0.474655	0.514167	38	0.505601	0.542756
38	0.548225	0.590335	39	0.580411	0.618069
39	0.622899	0.666611	40	0.656321	0.694574
40	0.700770	0.746343	41	0.733516	0.772458
41	0.786469	0.826595	42	0.812197	0.851936
42	0.866599	0.900866	43	0.892593	0.933251
43	0.950071	0.979932	44	0.974964	1.016666
44	1.033611	1.068756	45	1.059603	1.102530
45	1.124504	1.168733	46	1.146857	1.191183
46	1.221506	1.261339	47	1.237127	1.283072
47	1.309506	1.357674	48	1.330897	1.378722
48	1.408003	1.458403	49	1.428748	1.478773
49	1.511363	1.564324	50	1.531396	1.584019
50	1.620038	1.676442	51	1.639741	1.699546
51	1.736253	1.796064	52	1.754936	1.814408
52	1.860049	1.924926	53	1.878496	1.942585
53	1.999555	2.065424	54	2.012484	2.082384
54	2.143321	2.221004	55	2.159813	2.237243
55	2.300895	2.396902	56	2.324814	2.412386
56	2.499933	2.601700	57	2.514381	2.616377
57	2.726387	2.851074	58	2.740618	2.864858
58	3.041508	3.179088	59	3.028342	3.191826
59	3.434273	3.689458	60	3.446309	3.700791
ERROR = 0.000756			ERROR = 0.000732		
ENTROPY = 5.594452			ENTROPY = 5.618331		

TABLE I
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 61			N = 62		
J	X	Y	J	X	Y
31	-0.035035	0.000000	32	0.000000	0.034471
32	0.035035	0.070070	33	0.068970	0.103468
33	0.105162	0.140254	34	0.138049	0.172630
34	0.175462	0.210670	35	0.207349	0.242068
35	0.246053	0.281436	36	0.276983	0.311189
36	0.317056	0.352267	37	0.347067	0.382238
37	0.388595	0.424516	38	0.417726	0.453321
38	0.460805	0.497094	39	0.489908	0.524496
39	0.533382	0.570557	40	0.561289	0.597618
40	0.607809	0.645061	41	0.633448	0.671344
41	0.682291	0.720778	42	0.708826	0.746307
42	0.759938	0.797898	43	0.784501	0.822269
43	0.833726	0.876634	44	0.861707	0.899071
44	0.911692	0.957225	45	0.940666	0.978061
45	0.991692	1.039944	46	1.021633	1.060612
46	1.082252	1.125105	47	1.104900	1.147144
47	1.169909	1.213078	48	1.190806	1.233444
48	1.255368	1.304298	49	1.279751	1.323503
49	1.335179	1.399287	50	1.372213	1.419388
50	1.414892	1.498683	51	1.468876	1.518000
51	1.550097	1.603276	52	1.570113	1.622272
52	1.658672	1.714068	53	1.677719	1.733272
53	1.773212	1.832356	54	1.791098	1.849924
54	1.896112	1.959868	55	1.913358	1.976792
55	2.029429	2.099899	56	2.046023	2.115254
56	2.176068	2.253147	57	2.191992	2.263731
57	2.340352	2.427557	58	2.355579	2.424267
58	2.529159	2.630762	59	2.543647	2.644867
59	2.754568	2.878375	60	2.768249	2.891632
60	3.041348	3.204322	61	3.054108	3.216583
61	3.458118	3.711915	62	3.469710	3.722837
ERROR = 0.000708			ERROR = 0.000686		
ENTROPY = 5.641821			ENTROPY = 5.664934		

TABLE I
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 63			N = 64		
J	X	Y	J	X	Y
33	0.000000	0.000000	33	0.000000	0.033340
34	0.000000	0.067877	34	0.066844	0.100270
35	0.000000	0.135859	35	0.133787	0.167297
36	0.000000	0.204050	36	0.200093	0.234567
37	0.000000	0.272559	37	0.268380	0.302193
38	0.000000	0.341498	38	0.336233	0.370227
39	0.000000	0.410982	39	0.404615	0.438680
40	0.000000	0.481134	40	0.473332	0.508314
41	0.000000	0.552084	41	0.542408	0.578503
42	0.000000	0.623973	42	0.611407	0.649222
43	0.000000	0.696954	43	0.680578	0.721555
44	0.000000	0.771194	44	0.750895	0.795468
45	0.000000	0.846879	45	0.822292	0.870960
46	0.000000	0.924217	46	0.894884	0.948066
47	0.000000	1.003442	47	0.968642	1.027777
48	0.000000	1.084826	48	1.043112	1.109222
49	0.000000	1.168678	49	1.118375	1.192500
50	0.000000	1.255363	50	1.194404	1.277777
51	0.000000	1.345313	51	1.271275	1.365000
52	0.000000	1.439046	52	1.349009	1.454167
53	0.000000	1.537194	53	1.427705	1.545278
54	0.000000	1.640545	54	1.507210	1.639333
55	0.000000	1.750092	55	1.587575	1.736333
56	0.000000	1.866712	56	1.668759	1.837278
57	0.000000	1.990336	57	1.751794	1.942167
58	0.000000	2.131190	58	1.836721	2.052000
59	0.000000	2.284005	59	1.923589	2.166667
60	0.000000	2.457006	60	2.012433	2.286111
61	0.000000	2.658701	61	2.103279	2.410278
62	0.000000	2.904640	62	2.196140	2.539167
63	0.066622	3.228619	63	2.291922	2.672778
64	0.481091	3.733563	64	3.492269	3.744101
ERROR = 0.000665			ERROR = 0.000644		
ENTROPY = 5.687683			ENTROPY = 5.710078		

TABLE I
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 65				N = 66			
J	X	Y		J	X	Y	
33	0.0322299	0.000000		34	0.000000	0.0032411	
34	0.0098774	0.0065381		35	0.064845	0.0097279	
35	0.098774	0.1317330		36	0.1297822	0.1622284	
36	0.1647822	0.1978344		37	0.194901	0.2227518	
37	0.2311031	0.2642228		38	0.2602998	0.2923077	
38	0.329999	0.3331101		39	0.3226068	0.3590558	
39	0.4365522	0.3982222		40	0.3923122	0.4255655	
40	0.5432233	0.4666779		41	0.4593355	0.4920055	
41	0.6500000	0.5347789		42	0.5266650	0.5584444	
42	0.7566999	0.6004225		43	0.5944975	0.6248844	
43	0.8633999	0.6666666		44	0.6623240	0.6913244	
44	0.9700999	0.7333333		45	0.7301505	0.7577644	
45	1.0767999	0.8000000		46	0.7979770	0.8242044	
46	1.1834999	0.8666666		47	0.8658035	0.8906444	
47	1.2901999	0.9333333		48	0.9336300	0.9570844	
48	1.3968999	1.0000000		49	1.0014565	1.0235244	
49	1.5035999	1.0666666		50	1.0692830	1.0900000	
50	1.6102999	1.1333333		51	1.1371095	1.1564444	
51	1.7169999	1.2000000		52	1.2049360	1.2228844	
52	1.8236999	1.2666666		53	1.2727625	1.2893244	
53	1.9303999	1.3333333		54	1.3405890	1.3557644	
54	2.0370999	1.4000000		55	1.4084155	1.4222044	
55	2.1437999	1.4666666		56	1.4762420	1.4886444	
56	2.2504999	1.5333333		57	1.5440685	1.5550844	
57	2.3571999	1.6000000		58	1.6118950	1.6215244	
58	2.4638999	1.6666666		59	1.6797215	1.6879644	
59	2.5705999	1.7333333		60	1.7475480	1.7544044	
60	2.6772999	1.8000000		61	1.8153745	1.8208444	
61	2.7839999	1.8666666		62	1.8832010	1.8872844	
62	2.8906999	1.9333333		63	1.9510275	1.9537244	
63	2.9973999	2.0000000		64	2.0188540	2.0201644	
64	3.1040999	2.0666666		65	2.0866805	2.0866044	
65	3.2107999	2.1333333		66	2.1545070	2.1530444	
ERROR = 0.000625				ERROR = 0.000606			
ENTROPY = 5.732130				ENTROPY = 5.753849			

TABLE I
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 67			N = 68		
J	X	Y	J	X	Y
34	0.0311940	0.0000000	35	0.0000000	0.0311471
35	0.0311940	0.0638799	36	0.0622963	0.0994155
36	0.0995862	0.1278466	37	0.1260009	0.1575533
37	0.1599916	0.1919877	38	0.1892223	0.2208822
38	0.2224190	0.2563392	39	0.2526980	0.2844999
39	0.2883774	0.3211552	40	0.3164988	0.3484999
40	0.353762	0.3863699	41	0.3807400	0.4129000
41	0.413253	0.4521336	42	0.4455009	0.4780099
42	0.4683349	0.5185622	43	0.5109009	0.5437777
43	0.5122160	0.5857599	44	0.5770466	0.6103122
44	0.5619004	0.6533850	45	0.6440366	0.6777555
45	0.6080408	0.7229666	46	0.7120004	0.7462249
46	0.6500000	0.7932254	47	0.7808888	0.8155999
47	0.6884000	0.8643877	48	0.8511439	0.8869999
48	0.7229999	0.9360000	49	0.9233255	0.9599999
49	0.7544224	1.0080000	50	1.0000000	1.0333333
50	0.7822222	1.0800000	51	1.0718333	1.1066667
51	0.8066667	1.1520000	52	1.1442222	1.1800000
52	0.8277778	1.2240000	53	1.2166667	1.2533333
53	0.8455556	1.2960000	54	1.2890000	1.3266667
54	0.8600000	1.3680000	55	1.3611111	1.4000000
55	0.8722222	1.4400000	56	1.4333333	1.4733333
56	0.8822222	1.5120000	57	1.5055556	1.5466667
57	0.8900000	1.5840000	58	1.5777778	1.6200000
58	0.8955556	1.6560000	59	1.6500000	1.6933333
59	0.9000000	1.7280000	60	1.7222222	1.7666667
60	0.9033333	1.8000000	61	1.7944444	1.8400000
61	0.9055556	1.8720000	62	1.8666667	1.9133333
62	0.9066667	1.9440000	63	1.9388889	1.9866667
63	0.9077778	2.0160000	64	2.0111111	2.0600000
64	0.9088889	2.0880000	65	2.0833333	2.1333333
65	0.9099999	2.1600000	66	2.1555556	2.2066667
66	0.9111111	2.2320000	67	2.2277778	2.2800000
67	0.9122222	2.3040000	68	2.3000000	2.3533333
68	0.9133333	2.3760000			
69	0.9144444	2.4480000			
70	0.9155556	2.5200000			
71	0.9166667	2.5920000			
72	0.9177778	2.6640000			
73	0.9188889	2.7360000			
74	0.9199999	2.8080000			
75	0.9211111	2.8800000			
76	0.9222222	2.9520000			
77	0.9233333	3.0240000			
78	0.9244444	3.0960000			
79	0.9255556	3.1680000			
80	0.9266667	3.2400000			
81	0.9277778	3.3120000			
82	0.9288889	3.3840000			
83	0.9299999	3.4560000			
84	0.9311111	3.5280000			
85	0.9322222	3.6000000			
86	0.9333333	3.6720000			
87	0.9344444	3.7440000			
88	0.9355556	3.8160000			
89	0.9366667	3.8880000			
90	0.9377778	3.9600000			
91	0.9388889	4.0320000			
92	0.9399999	4.1040000			
93	0.9411111	4.1760000			
94	0.9422222	4.2480000			
95	0.9433333	4.3200000			
96	0.9444444	4.3920000			
97	0.9455556	4.4640000			
98	0.9466667	4.5360000			
99	0.9477778	4.6080000			
100	0.9488889	4.6800000			
101	0.9499999	4.7520000			
102	0.9511111	4.8240000			
103	0.9522222	4.8960000			
104	0.9533333	4.9680000			
105	0.9544444	5.0400000			
106	0.9555556	5.1120000			
107	0.9566667	5.1840000			
108	0.9577778	5.2560000			
109	0.9588889	5.3280000			
110	0.9599999	5.4000000			
111	0.9611111	5.4720000			
112	0.9622222	5.5440000			
113	0.9633333	5.6160000			
114	0.9644444	5.6880000			
115	0.9655556	5.7600000			
116	0.9666667	5.8320000			
117	0.9677778	5.9040000			
118	0.9688889	5.9760000			
119	0.9699999	6.0480000			
120	0.9711111	6.1200000			
121	0.9722222	6.1920000			
122	0.9733333	6.2640000			
123	0.9744444	6.3360000			
124	0.9755556	6.4080000			
125	0.9766667	6.4800000			
126	0.9777778	6.5520000			
127	0.9788889	6.6240000			
128	0.9799999	6.6960000			
129	0.9811111	6.7680000			
130	0.9822222	6.8400000			
131	0.9833333	6.9120000			
132	0.9844444	6.9840000			
133	0.9855556	7.0560000			
134	0.9866667	7.1280000			
135	0.9877778	7.2000000			
136	0.9888889	7.2720000			
137	0.9899999	7.3440000			
138	0.9911111	7.4160000			
139	0.9922222	7.4880000			
140	0.9933333	7.5600000			
141	0.9944444	7.6320000			
142	0.9955556	7.7040000			
143	0.9966667	7.7760000			
144	0.9977778	7.8480000			
145	0.9988889	7.9200000			
146	0.9999999	7.9920000			
147	1.0000000	8.0640000			
148	1.0000000	8.1360000			
149	1.0000000	8.2080000			
150	1.0000000	8.2800000			
151	1.0000000	8.3520000			
152	1.0000000	8.4240000			
153	1.0000000	8.4960000			
154	1.0000000	8.5680000			
155	1.0000000	8.6400000			
156	1.0000000	8.7120000			
157	1.0000000	8.7840000			
158	1.0000000	8.8560000			
159	1.0000000	8.9280000			
160	1.0000000	9.0000000			
161	1.0000000	9.0720000			
162	1.0000000	9.1440000			
163	1.0000000	9.2160000			
164	1.0000000	9.2880000			
165	1.0000000	9.3600000			
166	1.0000000	9.4320000			
167	1.0000000	9.5040000			
168	1.0000000	9.5760000			
169	1.0000000	9.6480000			
170	1.0000000	9.7200000			
171	1.0000000	9.7920000			
172	1.0000000	9.8640000			
173	1.0000000	9.9360000			
174	1.0000000	10.0080000			
175	1.0000000	10.0800000			
176	1.0000000	10.1520000			
177	1.0000000	10.2240000			
178	1.0000000	10.2960000			
179	1.0000000	10.3680000			
180	1.0000000	10.4400000			
181	1.0000000	10.5120000			
182	1.0000000	10.5840000			
183	1.0000000	10.6560000			
184	1.0000000	10.7280000			
185	1.0000000	10.8000000			
186	1.0000000	10.8720000			
187	1.0000000	10.9440000			
188	1.0000000	11.0160000			
189	1.0000000	11.0880000			
190	1.0000000	11.1600000			
191	1.0000000	11.2320000			
192	1.0000000	11.3040000			
193	1.0000000	11.3760000			
194	1.0000000	11.4480000			
195	1.0000000	11.5200000			
196	1.0000000	11.5920000			
197	1.0000000	11.6640000			
198	1.0000000	11.7360000			
199	1.0000000	11.8080000			
200	1.0000000	11.8800000			
201	1.0000000	11.9520000			
202	1.0000000	12.0240000			
203	1.0000000	12.0960000			
204	1.0000000	12.1680000			
205	1.0000000	12.2400000			
206	1.0000000	12.3120000			
207	1.0000000	12.3840000			
208	1.0000000	12.4560000			
209	1.0000000	12.5280000			
210	1.0000000	12.6000000			
211	1.0000000	12.6720000			
212	1.0000000	12.7440000			
213	1.0000000	12.8160000			
214	1.0000000	12.8880000			
215	1.0000000	12.9600000			
216	1.0000000	13.0320000			
217	1.0000000	13.1040000			
218	1.0000000	13.1760000			
219	1.0000000	13.2480000			
220	1.0000000	13.3200000			
221	1.0000000	13.3920000			
222	1.0000000	13.4640000			
223	1.0000000	13.5360000			
224	1.0000000	13.6080000			
225	1.0000000	13.6800000			
226	1.0000000	13.7520000			
227	1.0000000	13.8240000			
228	1.0000000	13.8960000			
229	1.0000000	13.9680000			
230	1.0000000	14.0400000			
231	1.0000000	14.1120000			
232	1.0000000	14.1840000			
233	1.0000000	14.2560000			
234	1.0000000	14.3280000			
235	1.0000000	14.4000000			
236	1.0000000	14.4720000			
237	1.0000000	14.5440000			
238	1.0000000	14.6160000			
239	1.0000000	14.6880000			
240	1.0000000	14.7600000			
241	1.0000000	14.8320000			
242	1.0000000	14.9040000			
243	1.0000000	14.9760000			
244	1.0000000	15.0480000			
245	1.0000000	15.1200000			
246	1.0000000	15.1920000			
247	1.0000000	15.2640000			
248	1.0000000	15.3360000			

TABLE I
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 69		N = 70	
J	X	J	X
0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9
10	10	10	10
11	11	11	11
12	12	12	12
13	13	13	13
14	14	14	14
15	15	15	15
16	16	16	16
17	17	17	17
18	18	18	18
19	19	19	19
20	20	20	20
21	21	21	21
22	22	22	22
23	23	23	23
24	24	24	24
25	25	25	25
26	26	26	26
27	27	27	27
28	28	28	28
29	29	29	29
30	30	30	30
31	31	31	31
32	32	32	32
33	33	33	33
34	34	34	34
35	35	35	35
36	36	36	36
37	37	37	37
38	38	38	38
39	39	39	39
40	40	40	40
41	41	41	41
42	42	42	42
43	43	43	43
44	44	44	44
45	45	45	45
46	46	46	46
47	47	47	47
48	48	48	48
49	49	49	49
50	50	50	50
51	51	51	51
52	52	52	52
53	53	53	53
54	54	54	54
55	55	55	55
56	56	56	56
57	57	57	57
58	58	58	58
59	59	59	59
60	60	60	60
61	61	61	61
62	62	62	62
63	63	63	63
64	64	64	64
65	65	65	65
66	66	66	66
67	67	67	67
68	68	68	68
69	69	69	69
70	70	70	70

TABLE 1
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 71		
J	X	Y
36	-0.030163	0.000000
37	0.030163	0.060326
38	0.090526	0.120726
39	0.151000	0.181273
40	0.211658	0.242043
41	0.272577	0.303111
42	0.333835	0.364559
43	0.395515	0.426470
44	0.457700	0.488930
45	0.520481	0.552033
46	0.583955	0.615877
47	0.648223	0.680569
48	0.713397	0.746225
49	0.779599	0.812972
50	0.846960	0.880948
51	0.915529	0.950309
52	0.985769	1.021229
53	1.057567	1.093390
54	1.131231	1.166855
55	1.207004	1.242544
56	1.285162	1.320476
57	1.366034	1.400719
58	1.450004	1.483281
59	1.537534	1.568252
60	1.629185	1.655761
61	1.725652	1.745855
62	1.827806	1.838542
63	1.936767	1.934810
64	2.054015	2.034922
65	2.181560	2.138999
66	2.322249	2.246299
67	2.480031	2.356433
68	2.662509	2.469685
69	2.880681	2.586678
70	3.159156	2.717633
71	3.565354	2.863074
ERROR = 0.000525		
ENTROPY = 5.857794		

N = 72		
J	X	Y
37	0.000000	0.029745
38	0.059508	0.089271
39	0.119086	0.148902
40	0.178806	0.208710
41	0.238739	0.268768
42	0.298960	0.329152
43	0.359544	0.389937
44	0.420573	0.451208
45	0.482128	0.513048
46	0.544298	0.575549
47	0.607179	0.638809
48	0.670871	0.702933
49	0.735484	0.768035
50	0.801138	0.834241
51	0.867965	0.901689
52	0.936111	0.970533
53	1.005740	1.040946
54	1.077034	1.113123
55	1.150205	1.187286
56	1.225430	1.263693
57	1.303168	1.342642
58	1.383564	1.424485
59	1.467061	1.509638
60	1.554121	1.598805
61	1.645304	1.692003
62	1.741301	1.790599
63	1.842982	1.895365
64	1.951465	2.007566
65	2.068227	2.128888
66	2.195274	2.261659
67	2.335446	2.409233
68	2.492972	2.576711
69	2.674586	2.772462
70	2.892123	3.011784
71	3.169865	3.327945
72	3.575124	3.822304
ERROR = 0.000511		
ENTROPY = 5.877713		

TABLE 1
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 73				N = 74			
J	X	Y		J	X	Y	
37	0	0	0	38	0	0	0
38	0	0	0	39	0	0	0
39	0	0	0	40	0	0	0
40	0	0	0	41	0	0	0
41	0	0	0	42	0	0	0
42	0	0	0	43	0	0	0
43	0	0	0	44	0	0	0
44	0	0	0	45	0	0	0
45	0	0	0	46	0	0	0
46	0	0	0	47	0	0	0
47	0	0	0	48	0	0	0
48	0	0	0	49	0	0	0
49	0	0	0	50	0	0	0
50	0	0	0	51	0	0	0
51	0	0	0	52	0	0	0
52	0	0	0	53	0	0	0
53	0	0	0	54	0	0	0
54	0	0	0	55	0	0	0
55	0	0	0	56	0	0	0
56	0	0	0	57	0	0	0
57	0	0	0	58	0	0	0
58	0	0	0	59	0	0	0
59	0	0	0	60	0	0	0
60	0	0	0	61	0	0	0
61	0	0	0	62	0	0	0
62	0	0	0	63	0	0	0
63	0	0	0	64	0	0	0
64	0	0	0	65	0	0	0
65	0	0	0	66	0	0	0
66	0	0	0	67	0	0	0
67	0	0	0	68	0	0	0
68	0	0	0	69	0	0	0
69	0	0	0	70	0	0	0
70	0	0	0	71	0	0	0
71	0	0	0	72	0	0	0
72	0	0	0	73	0	0	0
73	0	0	0	74	0	0	0

TABLE 1
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 75			N = 76		
J	X	Y	J	X	Y
38	-0.028574	0.000000	39	0.000000	0.028199
39	0.028574	0.057148	40	0.056413	0.084627
40	0.085753	0.114359	41	0.112885	0.141144
41	0.143026	0.171694	42	0.169479	0.197813
42	0.200456	0.229219	43	0.226253	0.254694
43	0.258108	0.286997	44	0.283272	0.311851
44	0.316047	0.345096	45	0.340600	0.369350
45	0.374342	0.403587	46	0.398304	0.427258
46	0.433064	0.462541	47	0.456454	0.485649
47	0.492289	0.522037	48	0.515123	0.544597
48	0.552096	0.582155	49	0.574389	0.604182
49	0.612569	0.642982	50	0.634337	0.664491
50	0.673798	0.704614	51	0.695054	0.725617
51	0.735882	0.767151	52	0.756639	0.787661
52	0.799927	0.830704	53	0.819197	0.850732
53	0.866305	0.895396	54	0.882842	0.914952
54	0.929379	0.961362	55	0.947704	0.980045
55	0.995057	1.028753	56	1.013924	1.047392
56	1.063246	1.097739	57	1.081662	1.115931
57	1.133125	1.168511	58	1.151097	1.186264
58	1.204901	1.241291	59	1.222426	1.258609
59	1.278881	1.316331	60	1.295914	1.333219
60	1.355129	1.393928	61	1.371804	1.410390
61	1.434417	1.474427	62	1.450428	1.490466
62	1.516336	1.558245	63	1.532165	1.573863
63	1.602063	1.645888	64	1.617470	1.661077
64	1.691912	1.737945	65	1.706898	1.752720
65	1.786572	1.833520	66	1.801135	1.849550
66	1.886907	1.933861	67	1.901042	1.952534
67	1.994027	2.049440	68	2.007730	2.062925
68	2.109399	2.169358	69	2.122661	2.182399
69	2.233502	2.300682	70	2.247829	2.313261
70	2.373715	2.446748	71	2.386053	2.458846
71	2.529639	2.612631	72	2.541533	2.624220
72	2.709644	2.806657	73	2.720957	2.817699
73	2.925354	3.044050	74	2.936083	3.054471
74	3.200985	3.357920	75	3.211039	3.367607
75	3.603540	3.849160	76	3.612727	3.857846
ERROR = 0.000471			ERROR = 0.000459		
ENTROPY = 5.935869			ENTROPY = 5.954745		

TABLE I
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 77			N = 78		
J	X	Y	J	X	Y
39	0.027841	0.000000	40	0.000000	0.027484
40	0.027841	0.055681	41	0.054983	0.082481
41	0.083551	0.111420	42	0.110021	0.137561
42	0.139348	0.167275	43	0.165171	0.192781
43	0.195290	0.223305	44	0.220489	0.248197
44	0.251437	0.279568	45	0.276033	0.303869
45	0.307849	0.336129	46	0.331862	0.359856
46	0.364590	0.393050	47	0.388003	0.416222
47	0.421725	0.450400	48	0.444627	0.473032
48	0.479323	0.508247	49	0.501694	0.530356
49	0.537457	0.566667	50	0.559311	0.588267
50	0.596203	0.625739	51	0.617555	0.646843
51	0.655643	0.685548	52	0.676506	0.706168
52	0.715866	0.746185	53	0.736225	0.766333
53	0.776699	0.807752	54	0.796887	0.827433
54	0.839054	0.870357	55	0.858516	0.889592
55	0.902238	0.934120	56	0.921252	0.952912
56	0.966647	0.999175	57	0.985522	1.017533
57	1.033242	1.065671	58	1.050560	1.083601
58	1.099723	1.133776	59	1.117443	1.151286
59	1.168728	1.203681	60	1.186030	1.220775
60	1.239643	1.275604	61	1.255653	1.292288
61	1.312700	1.349797	62	1.329181	1.366075
62	1.388175	1.426553	63	1.404251	1.442428
63	1.466386	1.506218	64	1.482060	1.521692
64	1.547711	1.589204	65	1.562985	1.604278
65	1.632606	1.676008	66	1.647480	1.690682
66	1.721624	1.767239	67	1.736097	1.781512
67	1.815448	1.863656	68	1.829518	1.877524
68	1.914939	1.966221	69	1.928603	1.979681
69	2.021204	2.076186	70	2.034455	2.089230
70	2.135704	2.195222	71	2.148535	2.207839
71	2.260429	2.325635	72	2.272826	2.337812
72	2.398193	2.470750	73	2.410140	2.482467
73	2.553188	2.635626	74	2.564661	2.646855
74	2.732094	2.828562	75	2.743059	2.839262
75	2.946648	3.064734	76	2.957052	3.074841
76	3.220942	3.377150	77	3.230696	3.386552
77	3.621778	3.866407	78	3.630698	3.874844
ERROR = 0.000447			ERROR = 0.000436		
ENTROPY = 5.973376			ENTROPY = 5.991770		

TABLE I
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 79		
J	X	Y
40	-0.0271444	0.0000000
41	0.0271444	0.0542888
42	0.0814599	0.1086300
43	0.1358554	0.1630778
44	0.1903884	0.2176899
45	0.2451033	0.2725177
46	0.3000688	0.3276119
47	0.3553337	0.3830555
48	0.4109770	0.4388886
49	0.4670311	0.4951177
50	0.5235866	0.5519996
51	0.5806705	0.6094155
52	0.6383846	0.6675122
53	0.6966941	0.7263700
54	0.7556224	0.7860079
55	0.8151640	0.8467338
56	0.8753195	0.9084533
57	0.9360888	0.9711344
58	1.0003444	1.0355422
59	1.0663364	1.1011196
60	1.1334833	1.1683471
61	1.2023011	1.2377558
62	1.2723114	1.3088671
63	1.3443367	1.3820622
64	1.4200042	1.4580233
65	1.4997459	1.5368966
66	1.5837794	1.6190933
67	1.6622100	1.7051107
68	1.7350322	1.7955545
69	1.8024354	1.8909163
70	1.9442042	1.9922920
71	2.0447491	2.1020622
72	2.1611559	2.2202555
73	2.2885026	2.3497997
74	2.4211900	2.4940002
75	2.5775957	2.6557912
76	2.7538857	2.8449801
77	2.9573000	3.0684799
78	3.2403008	3.3958166
79	3.6394889	3.8831661
ERROR =		0.000425
ENTROPY =		6.009932

N = 80		
J	X	Y
41	0.0000000	0.026805
42	0.053624	0.080442
43	0.107299	0.134156
44	0.161078	0.187999
45	0.215012	0.242025
46	0.269156	0.296287
47	0.323564	0.350842
48	0.378294	0.405746
49	0.433404	0.461062
50	0.488995	0.516852
51	0.545018	0.573184
52	0.601656	0.630012
53	0.658946	0.687763
54	0.716966	0.746168
55	0.775802	0.805436
56	0.835548	0.865561
57	0.896333	0.926692
58	0.958189	0.988996
59	1.021324	1.053321
60	1.085844	1.118646
61	1.151955	1.185534
62	1.219691	1.254038
63	1.288940	1.324763
64	1.361122	1.397769
65	1.435558	1.473334
66	1.512594	1.551840
67	1.592274	1.633365
68	1.676473	1.719290
69	1.764331	1.809934
70	1.856963	1.904579
71	1.955526	2.005946
72	2.060318	2.114699
73	2.173583	2.232477
74	2.297036	2.361596
75	2.433347	2.505360
76	2.587081	2.668880
77	2.764492	2.860183
78	2.977397	3.094610
79	3.249779	3.404948
80	3.648155	3.891362
ERROR =		0.000415
ENTROPY =		6.027868

TABLE 1
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 81			N = 82		
J	X	Y	J	X	Y
41	0.0264882	0.0000000	42	0.0000000	0.0261559
42	0.0264881	0.0529663	43	0.0523300	0.0785001
43	0.0794669	0.1059975	44	0.1047088	0.1309915
44	0.1322531	0.1590087	45	0.1571822	0.1834500
45	0.1857118	0.2123349	46	0.2098001	0.2361553
46	0.2390811	0.2658113	47	0.2626155	0.2890776
47	0.2926722	0.3195531	48	0.3156773	0.3422271
48	0.3465545	0.3735559	49	0.3690300	0.3957900
49	0.4007555	0.4279552	50	0.4227400	0.4496900
50	0.4553611	0.4827771	51	0.4768599	0.5040299
51	0.5104224	0.5380777	52	0.5314449	0.5588699
52	0.5660008	0.5939338	53	0.5865722	0.6142275
53	0.6221811	0.6504224	54	0.6422296	0.6703116
54	0.6790177	0.7076100	55	0.6986993	0.7270069
55	0.7365994	0.7655788	56	0.7558411	0.7846613
56	0.7949988	0.8244177	57	0.8138255	0.8433037
57	0.8543200	0.8842223	58	0.8727336	0.9024336
58	0.9146633	0.9451102	59	0.9322676	0.9629166
59	0.9761372	1.0077172	60	0.9933754	1.0245933
60	1.0388688	1.0705644	61	1.0566096	1.0875988
61	1.1029993	1.1354223	62	1.1198337	1.1520496
62	1.1686699	1.2019144	63	1.1851334	1.2181922
63	1.2360700	1.2702266	64	1.2521622	1.2861322
64	1.3054000	1.3405744	65	1.3211122	1.3556311
65	1.376889	1.4132205	66	1.3922244	1.4288377
66	1.450808	1.488410	67	1.4655798	1.5033219
67	1.5274771	1.5665322	68	1.5422099	1.5800979
68	1.6072255	1.6479777	69	1.6215211	1.6620063
69	1.6906009	1.7332240	70	1.7045133	1.7469663
70	1.7780081	1.8229223	71	1.7916222	1.8366281
71	1.8703511	1.9177779	72	1.8835225	1.9307699
72	1.9682711	2.0187664	73	1.9810775	2.0313388
73	2.0729422	2.1271200	74	2.0853699	2.1393566
74	2.1858113	2.2445006	75	2.1978554	2.2563522
75	2.3088600	2.3732214	76	2.3205004	2.3846566
76	2.4448800	2.5165466	77	2.4561100	2.5275664
77	2.5930337	2.6795299	78	2.6088331	2.6900998
78	2.7749770	2.8704122	79	2.7852955	2.8804992
79	2.9933466	3.1042800	80	2.9971522	3.1138111
80	3.2591155	3.4139500	81	3.2683188	3.4228226
81	3.6567000	3.8994500	82	3.6651226	3.9074227
ERROR = 0.000405			ERROR = 0.000395		
ENTROPY = 6.045584			ENTROPY = 6.063084		

TABLE 1
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 83			N = 84		
J	X	Y	J	X	Y
42	-0.0255851	0.0000000	43	0.0000000	0.0255543
43	0.0255850	0.0517001	44	0.0510998	0.0766522
44	0.0777574	0.1034448	45	0.1022240	0.1278228
45	0.1293368	0.1552887	46	0.1534722	0.1791115
46	0.1812777	0.2072666	47	0.2048338	0.2305600
47	0.2333350	0.2594333	48	0.2563855	0.2822110
48	0.2856334	0.3118336	49	0.3081611	0.3334111
49	0.3381811	0.3645255	50	0.3603333	0.3866315
50	0.3910440	0.4175555	51	0.4122222	0.4388871
51	0.4412667	0.4709799	52	0.4653333	0.4918855
52	0.4979117	0.5248854	53	0.5185499	0.5452263
53	0.5520499	0.5792243	54	0.5722222	0.5999955
54	0.6066726	0.6342009	55	0.6264444	0.6555555
55	0.6620115	0.6898221	56	0.6813333	0.7088951
56	0.7179887	0.7461533	57	0.7369944	0.7648866
57	0.7747220	0.8032287	58	0.7932244	0.8224611
58	0.8332297	0.8613008	59	0.8500426	0.8819322
59	0.8908110	0.9203122	60	0.9088355	0.9333333
60	0.9503558	0.9804004	61	0.9677199	0.9999999
61	1.0110552	1.0417000	62	1.0280000	1.0555555
62	1.0730114	1.1043229	63	1.0896334	1.1120766
63	1.1363883	1.1684337	64	1.1526440	1.1845113
64	1.2013111	1.2341886	65	1.2172100	1.2499907
65	1.2679776	1.3017665	66	1.2833519	1.3171332
66	1.3365775	1.3713885	67	1.3517668	1.3864003
67	1.4073440	1.4432955	68	1.4222184	1.4579966
68	1.4805339	1.5177833	69	1.4950033	1.5332108
69	1.5564886	1.5951889	70	1.5706338	1.6099169
70	1.6355554	1.6759200	71	1.6493362	1.6889555
71	1.7181922	1.7604655	72	1.7316554	1.7737554
72	1.8049466	1.8494227	73	1.8180061	1.8623668
73	1.8964922	1.9433556	74	1.9092256	1.9556145
74	1.9933679	2.0433802	75	2.0060000	2.0566334
75	2.0976004	2.1514066	76	2.1096533	2.1633773
76	2.2097112	2.2688019	77	2.2213392	2.2719555
77	2.3319773	2.3959226	78	2.3433211	2.4010000
78	2.4671773	2.5384200	79	2.4718000	2.5449111
79	2.6194667	2.7005113	80	2.6299944	2.7100778
80	2.7954771	2.8904223	81	2.8053001	2.9000224
81	3.0068118	3.1232208	82	3.0186334	3.1324772
82	3.2773993	3.4315778	83	3.2866334	3.4440224
83	3.6734338	3.9152977	84	3.6816337	3.9230661
ERROR = 0.000386			ERROR = 0.000377		
ENTROPY = 6.080375			ENTROPY = 6.097461		

TABLE 1
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N =		85	
J	X	Y	
43	-	0	0
44	0	0	0
45	0	0	0
46	0	0	0
47	0	0	0
48	0	0	0
49	0	0	0
50	0	0	0
51	0	0	0
52	0	0	0
53	0	0	0
54	0	0	0
55	0	0	0
56	0	0	0
57	0	0	0
58	0	0	0
59	0	0	0
60	0	0	0
61	0	0	0
62	0	0	0
63	0	0	0
64	0	0	0
65	0	0	0
66	0	0	0
67	0	0	0
68	0	0	0
69	0	0	0
70	0	0	0
71	0	0	0
72	0	0	0
73	0	0	0
74	0	0	0
75	0	0	0
76	0	0	0
77	0	0	0
78	0	0	0
79	0	0	0
80	0	0	0
81	0	0	0
82	0	0	0
83	0	0	0
84	0	0	0
85	0	0	0

N =		86	
J	X	Y	
44	0.00000	0.02449	56
45	0.00499	0.07488	88
46	0.00999	0.12488	33
47	0.01499	0.17444	22
48	0.01999	0.22227	7
49	0.02500	0.27566	33
50	0.03000	0.32763	34
51	0.03500	0.37772	86
52	0.04000	0.42488	66
53	0.04500	0.46888	55
54	0.05000	0.50999	55
55	0.05500	0.54888	55
56	0.06000	0.58666	11
57	0.06500	0.62333	11
58	0.07000	0.65999	88
59	0.07500	0.69444	40
60	0.08000	0.72777	87
61	0.08500	0.75999	66
62	0.09000	0.79000	42
63	0.09500	0.81888	22
64	0.10000	0.84666	33
65	0.10500	0.87333	44
66	0.11000	0.90000	55
67	0.11500	0.92666	66
68	0.12000	0.95333	77
69	0.12500	0.98000	88
70	0.13000	1.00666	99
71	0.13500	1.03333	10
72	0.14000	1.06000	21
73	0.14500	1.08666	32
74	0.15000	1.11333	43
75	0.15500	1.14000	54
76	0.16000	1.16666	65
77	0.16500	1.19333	76
78	0.17000	1.22000	87
79	0.17500	1.24666	98
80	0.18000	1.27333	09
81	0.18500	1.30000	20
82	0.19000	1.32666	31
83	0.19500	1.35333	42
84	0.20000	1.38000	53
85	0.20500	1.40666	64
86	0.21000	1.43333	75
87	0.21500	1.46000	86
88	0.22000	1.48666	97
89	0.22500	1.51333	08
90	0.23000	1.54000	19
91	0.23500	1.56666	30
92	0.24000	1.59333	41
93	0.24500	1.62000	52
94	0.25000	1.64666	63
95	0.25500	1.67333	74
96	0.26000	1.70000	85
97	0.26500	1.72666	96
98	0.27000	1.75333	07
99	0.27500	1.78000	18
100	0.28000	1.80666	29

TABLE 1
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 87			N = 88		
J	X	Y	J	X	Y
44	-0.024675	0.000000	45	0.000000	0.024395
45	0.024674	0.049349	46	0.048799	0.073203
46	0.074044	0.098738	47	0.097637	0.122070
47	0.123347	0.148208	48	0.146552	0.171035
48	0.173003	0.197799	49	0.195585	0.220136
49	0.222675	0.247552	50	0.244775	0.269415
50	0.272531	0.297511	51	0.294164	0.318913
51	0.322615	0.347718	52	0.343793	0.368673
52	0.372969	0.398220	53	0.393706	0.418739
53	0.423641	0.449062	54	0.443948	0.469158
54	0.474678	0.500029	55	0.494567	0.519977
55	0.526131	0.551196	56	0.545612	0.571248
56	0.578053	0.602638	57	0.597136	0.623024
57	0.630499	0.655686	58	0.649194	0.675364
58	0.683531	0.710201	59	0.701845	0.728327
59	0.737221	0.764223	60	0.755154	0.781980
60	0.791611	0.818999	61	0.809188	0.836395
61	0.846683	0.874600	62	0.864022	0.891648
62	0.902386	0.931133	63	0.919736	0.947824
63	0.959937	0.988664	64	0.976411	1.005015
64	1.017727	1.047310	65	1.034116	1.063323
65	1.077246	1.107182	66	1.093303	1.122862
66	1.137794	1.168406	67	1.153310	1.183758
67	1.199767	1.231277	68	1.214956	1.246155
68	1.263317	1.295506	69	1.277818	1.310211
69	1.328862	1.361726	70	1.343162	1.376112
70	1.395886	1.429999	71	1.410090	1.444400
71	1.465284	1.500000	72	1.479196	1.514323
72	1.537714	1.573372	73	1.550742	1.587162
73	1.611175	1.649796	74	1.625042	1.662921
74	1.689944	1.729193	75	1.702462	1.742003
75	1.770797	1.812400	76	1.783449	1.824894
76	1.855207	1.900001	77	1.868542	1.912189
77	1.944633	1.992780	78	1.958410	2.004631
78	2.042221	2.091642	79	2.053898	2.103166
79	2.144473	2.197832	80	2.156092	2.209919
80	2.255544	2.312992	81	2.266427	2.323383
81	2.376113	2.439339	82	2.386855	2.444987
82	2.509984	2.580306	83	2.520145	2.590413
83	2.660511	2.740717	84	2.670418	2.750422
84	2.834755	2.929802	85	2.844246	2.938070
85	3.044161	3.159520	86	3.053182	3.168295
86	3.312472	3.465423	87	3.320951	3.473608
87	3.705588	3.945753	88	3.713365	3.953123
ERROR = 0.000351			ERROR = 0.000344		
ENTROPY = 6.147535			ENTROPY = 6.163848		

TABLE 1
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 89			N = 90		
J	X	Y	J	X	Y
45	0.024126	0.000000	46	0.000000	0.023858
46	0.024126	0.048252	47	0.047725	0.071593
47	0.072396	0.096541	48	0.095487	0.119382
48	0.120723	0.144905	49	0.143322	0.167262
49	0.169144	0.193383	50	0.191266	0.215270
50	0.217697	0.242012	51	0.239358	0.263345
51	0.266423	0.290083	52	0.287634	0.311824
52	0.315335	0.338887	53	0.336135	0.360047
53	0.364455	0.389214	54	0.384902	0.409357
54	0.414033	0.438859	55	0.433397	0.458855
55	0.463080	0.488868	56	0.483400	0.508820
56	0.511700	0.539016	57	0.533322	0.558822
57	0.560954	0.590168	58	0.583348	0.608874
58	0.610777	0.641563	59	0.634225	0.659955
59	0.660190	0.693352	60	0.685567	0.711369
60	0.710190	0.746612	61	0.737491	0.763361
61	0.760772	0.799942	62	0.790087	0.816561
62	0.812206	0.853348	63	0.843422	0.870022
63	0.864494	0.906833	64	0.897570	0.924085
64	0.919900	0.960443	65	0.952611	0.978866
65	0.976600	1.021089	66	1.008621	1.036866
66	1.035900	1.089969	67	1.065722	1.099955
67	1.098000	1.168886	68	1.124004	1.168886
68	1.166000	1.258860	69	1.183358	1.244444
69	1.239900	1.360939	70	1.244603	1.327777
70	1.320000	1.484682	71	1.307206	1.420000
71	1.395000	1.630271	72	1.371567	1.520000
72	1.474400	1.799188	73	1.437882	1.637777
73	1.559200	1.999999	74	1.506377	1.777777
74	1.650000	2.233333	75	1.577315	1.944444
75	1.756666	2.500000	76	1.651006	2.144444
76	1.880000	2.800000	77	1.727818	2.388888
77	1.995000	3.142857	78	1.808193	2.677777
78	2.100000	3.529411	79	1.892670	3.000000
79	2.200000	3.960784	80	1.981916	3.366666
80	2.300000	4.444444	81	2.076772	3.777777
81	2.400000	4.977777	82	2.178322	4.233333
82	2.500000	5.560000	83	2.287995	4.733333
83	2.600000	6.192307	84	2.407726	5.277777
84	2.700000	6.875000	85	2.540313	5.866666
85	2.800000	7.607142	86	2.688922	6.500000
86	2.900000	8.388888	87	2.862841	7.177777
87	3.000000	9.222222	88	3.070871	7.900000
88	3.100000	10.111111	89	3.337583	8.666666
89	3.200000	11.055555	90	3.728626	9.555555
90	3.300000	12.055555			
ERROR = 0.000336			ERROR = 0.000329		
ENTROPY = 6.179978			ENTROPY = 6.195929		

TABLE I
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 91			N = 92		
J	X	Y	J	X	Y
46	0.0233601	0.0000000	47	0.0000000	0.0233345
47	0.0233601	0.047202	48	0.046698	0.070052
48	0.0708220	0.094439	49	0.093431	0.116810
49	0.1118093	0.141746	50	0.140231	0.163653
50	0.165453	0.189160	51	0.187134	0.210616
51	0.212938	0.236715	52	0.234175	0.257734
52	0.260583	0.284450	53	0.281389	0.305044
53	0.308422	0.332240	54	0.328814	0.352583
54	0.356506	0.380061	55	0.376486	0.400389
55	0.404862	0.427911	56	0.424446	0.448502
56	0.453537	0.475795	57	0.472733	0.496964
57	0.502572	0.522718	58	0.521390	0.545817
58	0.552013	0.570684	59	0.570463	0.595109
59	0.601909	0.622697	60	0.619999	0.644888
60	0.652309	0.677642	61	0.670047	0.695205
61	0.703326	0.728899	62	0.720661	0.746116
62	0.754845	0.780794	63	0.771898	0.797680
63	0.807099	0.833340	64	0.823821	0.849961
64	0.860099	0.886679	65	0.876495	0.903028
65	0.913917	0.941041	66	0.929993	0.956957
66	0.968634	0.996226	67	0.984393	1.011830
67	1.024444	1.052442	68	1.039784	1.067737
68	1.081111	1.109790	69	1.096259	1.124780
69	1.139908	1.168380	70	1.153925	1.183070
70	1.198360	1.228339	71	1.212901	1.242232
71	1.255907	1.289980	72	1.273319	1.303906
72	1.321376	1.352945	73	1.335322	1.366751
73	1.385433	1.417934	74	1.399910	1.431449
74	1.451458	1.484932	75	1.464820	1.496999
75	1.519658	1.554333	76	1.532740	1.563722
76	1.590302	1.626270	77	1.603096	1.633892
77	1.663369	1.701127	78	1.676206	1.713490
78	1.740211	1.779305	79	1.752434	1.791378
79	1.822029	1.861285	80	1.832223	1.877306
80	1.900447	1.947766	81	1.916109	1.959151
81	1.999341	2.039174	82	2.004758	2.050036
82	2.087968	2.136762	83	2.099907	2.147649
83	2.189204	2.241647	84	2.199937	2.252224
84	2.299955	2.355464	85	2.308973	2.365771
85	2.411706	2.480046	86	2.428057	2.490494
86	2.550019	2.619919	87	2.559943	2.629954
87	2.699933	2.778765	88	2.708929	2.787994
88	2.871955	2.965146	89	2.880952	2.977393
89	3.079943	3.193941	90	3.088105	3.202212
90	3.345739	3.497537	91	3.353794	3.505315
91	3.736113	3.974689	92	3.743508	3.981702
ERROR = 0.000321			ERROR = 0.000315		
ENTROPY = 6.211706			ENTROPY = 6.227312		

TABLE 1
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 93			N = 94		
J	X	Y	J	X	Y
47	-0.023309	0.000000	48	0.000000	0.002285
48	0.002330	0.004619	49	0.004571	0.006857
49	0.006933	0.009242	50	0.009146	0.011434
50	0.011555	0.013872	51	0.013727	0.016011
51	0.016119	0.018511	52	0.018317	0.020615
52	0.020833	0.023164	53	0.022921	0.025226
53	0.025449	0.027834	54	0.027541	0.029855
54	0.030088	0.032524	55	0.032180	0.034505
55	0.034881	0.037233	56	0.036843	0.039180
56	0.039669	0.041977	57	0.041533	0.043884
57	0.044436	0.046753	58	0.046225	0.048621
58	0.049195	0.051562	59	0.050908	0.053392
59	0.053958	0.056411	60	0.055580	0.058197
60	0.058727	0.061300	61	0.060263	0.063035
61	0.063491	0.066228	62	0.064952	0.067907
62	0.068251	0.071194	63	0.069650	0.072812
63	0.073007	0.076198	64	0.074365	0.077751
64	0.077759	0.081241	65	0.079044	0.082724
65	0.082507	0.086322	66	0.083692	0.087731
66	0.087251	0.091442	67	0.088353	0.092772
67	0.091991	0.096601	68	0.092935	0.097847
68	0.096727	0.101800	69	0.097481	0.102957
69	0.101459	0.107038	70	0.101934	0.108101
70	0.106187	0.112313	71	0.106399	0.113279
71	0.110911	0.117628	72	0.110782	0.118491
72	0.115631	0.122982	73	0.115533	0.123737
73	0.120347	0.128375	74	0.120211	0.129017
74	0.125059	0.133808	75	0.124957	0.134330
75	0.129767	0.139280	76	0.129660	0.139677
76	0.134471	0.144792	77	0.134325	0.145058
77	0.139171	0.150344	78	0.139053	0.150473
78	0.143868	0.155935	79	0.143781	0.155922
79	0.148561	0.161566	80	0.148533	0.161500
80	0.153251	0.167237	81	0.153245	0.167515
81	0.157938	0.172948	82	0.157917	0.172961
82	0.162621	0.178699	83	0.162616	0.178988
83	0.167301	0.184490	84	0.167300	0.184938
84	0.171978	0.190321	85	0.171993	0.190911
85	0.176651	0.196192	86	0.176688	0.196906
86	0.181321	0.202103	87	0.181385	0.202922
87	0.185988	0.208054	88	0.185999	0.208959
88	0.190651	0.214045	89	0.190668	0.214994
89	0.195311	0.220076	90	0.195333	0.221028
90	0.199968	0.226147	91	0.199989	0.227061
91	0.204621	0.232258	92	0.204646	0.233093
92	0.209271	0.238409	93	0.209299	0.239125
93	0.213918	0.244600	94	0.213931	0.245157
ERROR = 0.000308			ERROR = 0.000301		
ENTROPY = 6.242751			ENTROPY = 6.258027		

TABLE 1
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 95			N = 96		
J	X	Y	J	X	Y
48	0.0222617	0.0000000	49	0.0000000	0.0222382
49	0.0222617	0.0045234	50	0.0044771	0.0671660
50	0.0670866	0.0090499	51	0.0089572	0.1111984
51	0.1133162	0.0135826	52	0.1334433	0.1566884
52	0.1558536	0.0181246	53	0.1793855	0.2018887
53	0.2040018	0.0226791	54	0.2244457	0.2470288
54	0.2449642	0.0272493	55	0.2669683	0.2923338
55	0.2949999	0.0318386	56	0.3150093	0.3337848
56	0.3341451	0.0364503	57	0.3607211	0.3835943
57	0.3877692	0.0410811	58	0.4066000	0.4229907
58	0.4434275	0.0455632	59	0.4522767	0.4759229
59	0.5008225	0.0501947	60	0.4999258	0.5225889
60	0.5578844	0.0551947	61	0.5446111	0.5696244
61	0.6233888	0.0606008	62	0.5933663	0.6117102
62	0.6622333	0.0667708	63	0.6411071	0.6650399
63	0.7277777	0.0746610	64	0.6899265	0.7134491
64	0.7721111	0.0796600	65	0.7380000	0.7625003
65	0.8333333	0.0846600	66	0.7887326	0.8121143
66	0.8888888	0.0896600	67	0.8337299	0.8622455
67	0.9555555	0.0950055	68	0.8887990	0.9135005
68	1.0333333	0.111766	69	0.9339433	0.9655361
69	1.0846666	0.112184	70	0.9917299	1.0180097
70	1.1400000	0.116833	71	1.0444946	1.0717995
71	1.1999999	0.122257	72	1.0999169	1.1265542
72	1.2555555	0.128457	73	1.1544491	1.1822400
73	1.3111111	0.134499	74	1.2111018	1.2399977
74	1.3333333	0.140699	75	1.2688867	1.2988136
75	1.3759322	0.146993	76	1.3288167	1.3588199
76	1.4338888	0.153673	77	1.3899068	1.4199999
77	1.5009377	0.160473	78	1.4551733	1.4833333
78	1.5570888	0.167373	79	1.5166371	1.5492004
79	1.6133333	0.174373	80	1.5833190	1.6177776
80	1.6711111	0.181373	81	1.6522455	1.6877733
81	1.7300000	0.188373	82	1.7224471	1.7612009
82	1.7888888	0.195373	83	1.7999660	1.8337999
83	1.8677777	0.202373	84	1.8788290	1.9111111
84	1.9500000	0.209373	85	1.9510663	2.0033333
85	2.0333333	0.216373	86	2.0433584	2.0999999
86	2.1222222	0.223373	87	2.1416887	2.1899999
87	2.2333333	0.230373	88	2.2414445	2.2933333
88	2.3333333	0.237373	89	2.3492276	2.4055555
89	2.4577777	0.244373	90	2.4677111	2.5288888
90	2.5833333	0.251373	91	2.5976889	2.6666666
91	2.7361111	0.258373	92	2.7450888	2.8233333
92	2.9072222	0.265373	93	2.9158111	3.0080000
93	3.1133333	0.272373	94	3.1212996	3.2345555
94	3.3777777	0.280081	95	3.3850333	3.5354889
95	3.765163	0.300224	96	3.7722210	4.0089932
ERROR = 0.000295			ERROR = 0.000289		
ENTROPY = 6.273142			ENTROPY = 6.288101		

TABLE I
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

[illegible]

TABLE I
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 99			N = 100		
J	X	Y	J	X	Y
50	0.021712	0.000000	51	0.000000	0.021495
51	0.021712	0.043423	52	0.042997	0.064498
52	0.065149	0.086874	53	0.086020	0.107541
53	0.108627	0.130380	54	0.129096	0.150651
54	0.152174	0.173968	55	0.172253	0.193854
55	0.195817	0.217667	56	0.215516	0.237179
56	0.239585	0.261504	57	0.258915	0.280652
57	0.283507	0.305510	58	0.302477	0.324302
58	0.327612	0.349714	59	0.346231	0.368160
59	0.371930	0.394147	60	0.390207	0.412255
60	0.416493	0.438840	61	0.434437	0.456619
61	0.461334	0.483828	62	0.478951	0.501284
62	0.506487	0.529145	63	0.523785	0.546285
63	0.551986	0.574827	64	0.568972	0.591659
64	0.597870	0.620912	65	0.614550	0.637442
65	0.644177	0.667441	66	0.660558	0.683674
66	0.690949	0.714457	67	0.707037	0.730399
67	0.738232	0.762006	68	0.754031	0.777662
68	0.786071	0.810136	69	0.801587	0.825511
69	0.834517	0.858899	70	0.849755	0.873999
70	0.883626	0.908354	71	0.898590	0.923181
71	0.933345	0.958560	72	0.948150	0.973120
72	0.984072	1.009584	73	0.998500	1.023880
73	1.035543	1.061501	74	1.049708	1.075536
74	1.087945	1.114389	75	1.101852	1.128167
75	1.141363	1.168337	76	1.155014	1.181860
76	1.195890	1.223443	77	1.209287	1.236715
77	1.251630	1.279816	78	1.264776	1.292838
78	1.308698	1.337579	79	1.321595	1.350353
79	1.367224	1.396869	80	1.379875	1.409397
80	1.427356	1.457843	81	1.439761	1.470125
81	1.489261	1.520679	82	1.501422	1.532717
82	1.553311	1.585583	83	1.565047	1.597378
83	1.619188	1.652793	84	1.630861	1.664344
84	1.687991	1.722589	85	1.699912	1.733896
85	1.759945	1.795300	86	1.770129	1.806362
86	1.833310	1.871321	87	1.844249	1.882136
87	1.911224	1.951128	88	1.921915	1.961694
88	1.993321	2.035306	89	2.000365	2.045620
89	2.079947	2.124588	90	2.090133	2.134645
90	2.172244	2.219901	91	2.182171	2.229697
91	2.271178	2.322454	92	2.280839	2.333198
92	2.379159	2.433864	93	2.388754	2.444311
93	2.495113	2.555636	94	2.504217	2.565332
94	2.624768	2.693172	95	2.633574	2.701825
95	2.771185	2.849198	96	2.779674	2.857523
96	2.940846	3.032494	97	2.948992	3.040461
97	3.145146	3.257799	98	3.152910	3.265359
98	3.407497	3.557195	99	3.414812	3.564265
99	3.792867	4.028540	100	3.799597	4.034929
ERROR = 0.000272			ERROR = 0.000267		
ENTROPY = 6.332067			ENTROPY = 6.346430		

TABLE 1
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 101			N = 102		
J	X	Y	J	X	Y
51	0.021286	0.000000	52	0.000000	0.021077
52	0.021286	0.042572	53	0.042161	0.063245
53	0.063870	0.085169	54	0.084347	0.105350
54	0.106494	0.127818	55	0.126584	0.147418
55	0.149181	0.170545	56	0.168809	0.189444
56	0.191960	0.213375	57	0.211133	0.232504
57	0.234856	0.256337	58	0.253388	0.275444
58	0.277897	0.299457	59	0.296542	0.317911
59	0.321110	0.342763	60	0.339651	0.360323
60	0.364524	0.386285	61	0.382255	0.402900
61	0.408168	0.430052	62	0.425588	0.445449
62	0.452073	0.474095	63	0.469441	0.488030
63	0.496627	0.518447	64	0.513334	0.530636
64	0.540794	0.563142	65	0.557522	0.573269
65	0.585567	0.608215	66	0.602111	0.615930
66	0.630955	0.653703	67	0.647111	0.658615
67	0.676667	0.699647	68	0.692536	0.701325
68	0.722868	0.746089	69	0.738451	0.744060
69	0.769581	0.793073	70	0.784800	0.786830
70	0.816861	0.840649	71	0.831900	0.829635
71	0.864758	0.888867	72	0.879000	0.872465
72	0.913332	0.937784	73	0.927111	0.915320
73	0.962263	0.987461	74	0.975833	0.958200
74	1.011271	1.037994	75	1.024667	1.001105
75	1.063666	1.089365	76	1.073900	1.044035
76	1.115555	1.141174	77	1.123600	1.086990
77	1.168446	1.195189	78	1.173777	1.129970
78	1.222499	1.249977	79	1.224355	1.172975
79	1.277736	1.305676	80	1.275355	1.215995
80	1.334433	1.362298	81	1.326855	1.259030
81	1.392334	1.421750	82	1.378855	1.302080
82	1.451199	1.482233	83	1.431355	1.345145
83	1.511334	1.544592	84	1.484355	1.388225
84	1.572688	1.609013	85	1.537855	1.431320
85	1.642377	1.675741	86	1.591855	1.474430
86	1.710397	1.745053	87	1.646355	1.517555
87	1.781166	1.817279	88	1.701355	1.560695
88	1.855504	1.892810	89	1.756855	1.603850
89	1.932467	1.972212	90	1.812855	1.646920
90	2.011399	2.055803	91	1.869355	1.690005
91	2.100011	2.144576	92	1.926355	1.733105
92	2.199038	2.239337	93	1.983855	1.776220
93	2.299000	2.341399	94	2.041855	1.819350
94	2.399688	2.452248	95	2.100355	1.862495
95	2.501227	2.574172	96	2.159355	1.905655
96	2.604222	2.710337	97	2.218855	1.948830
97	2.708800	2.865750	98	2.278855	1.992020
98	2.815704	3.043334	99	2.339355	2.035225
99	2.950589	3.272832	100	2.399355	2.078445
100	3.160589	3.571254	101	2.458855	2.121680
101	3.422043	4.041248	102	2.517855	2.164930
ERROR = 0.000262			ERROR = 0.000256		
ENTROPY = 6.360651			ENTROPY = 6.374733		

TABLE 1
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 103			N = 104		
J	X	Y	J	X	Y
52	0.020876	0.000000	53	0.000000	0.020676
53	0.020876	0.004175	54	0.041358	0.062039
54	0.062641	0.008352	55	0.082739	0.103438
55	0.104442	0.012535	56	0.124167	0.144899
56	0.146630	0.016725	57	0.165667	0.186438
57	0.188252	0.020925	58	0.207262	0.228008
58	0.230031	0.025137	59	0.248977	0.269868
59	0.272505	0.029364	60	0.290837	0.311800
60	0.314863	0.033608	61	0.332868	0.353929
61	0.357409	0.037873	62	0.375096	0.396262
62	0.400172	0.042161	63	0.417547	0.438833
63	0.443181	0.046475	64	0.460225	0.481671
64	0.486465	0.050817	65	0.503238	0.524805
65	0.530055	0.055193	66	0.546553	0.568267
66	0.573988	0.059603	67	0.590179	0.612091
67	0.618299	0.064053	68	0.634200	0.656309
68	0.662999	0.068545	69	0.678863	0.700960
69	0.708174	0.073084	70	0.723352	0.746081
70	0.753792	0.077674	71	0.768898	0.791715
71	0.799996	0.082318	72	0.814810	0.837905
72	0.846677	0.087023	73	0.861301	0.884698
73	0.894640	0.091793	74	0.908842	0.932214
74	0.942213	0.096634	75	0.956622	0.980005
75	0.990093	0.101551	76	1.004411	1.027923
76	1.038005	0.106551	77	1.054411	1.078998
77	1.090000	0.111642	78	1.104433	1.129966
78	1.142233	0.116831	79	1.155449	1.181322
79	1.194488	0.122128	80	1.207699	1.233405
80	1.246833	0.127541	81	1.261005	1.287795
81	1.300311	0.133081	82	1.315543	1.343113
82	1.355221	0.138762	83	1.371418	1.400055
83	1.416780	0.144595	84	1.428771	1.457813
84	1.475966	0.150578	85	1.487712	1.517610
85	1.533699	0.156606	86	1.548442	1.579273
86	1.599888	0.162782	87	1.611133	1.643300
87	1.666449	0.169008	88	1.676602	1.709944
88	1.732251	0.176693	89	1.744335	1.777664
89	1.800888	0.183869	90	1.813342	1.849195
90	1.877622	0.191375	91	1.888666	1.924026
91	1.955311	0.199259	92	1.966332	2.002632
92	2.034411	0.207578	93	2.044411	2.085593
93	2.119999	0.216406	94	2.129966	2.173637
94	2.211111	0.225836	95	2.220066	2.267684
95	2.309999	0.235986	96	2.318311	2.368938
96	2.415028	0.247013	97	2.422399	2.479900
97	2.530087	0.259155	98	2.539955	2.600098
98	2.659965	0.272717	99	2.667761	2.735422
99	2.804455	0.288191	100	2.812644	2.889863
100	2.972865	0.306338	101	2.988064	3.071418
101	3.175668	0.328752	102	3.183083	3.294748
102	3.436263	0.358500	103	3.443254	3.591760
103	3.819341	0.405368	104	3.825779	4.059797
ERROR = 0.000252			ERROR = 0.000247		
ENTROPY = 6.388678			ENTROPY = 6.402491		

TABLE 1
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 105			N = 106		
J	X	Y	J	X	Y
53	0.020482	0.000000	54	0.000000	0.020289
54	0.020482	0.000000	55	0.040584	0.060879
55	0.061458	0.008195	56	0.081190	0.101502
56	0.102468	0.012298	57	0.121842	0.142181
57	0.143533	0.016408	58	0.162560	0.182939
58	0.184685	0.020528	59	0.203368	0.223798
59	0.225938	0.024659	60	0.244290	0.264782
60	0.267322	0.028804	61	0.285349	0.305915
61	0.308855	0.032996	62	0.326568	0.347221
62	0.350568	0.037147	63	0.367974	0.388726
63	0.392486	0.041350	64	0.409591	0.430455
64	0.434636	0.045577	65	0.451445	0.472433
65	0.477704	0.049831	66	0.493356	0.514696
66	0.519744	0.054116	67	0.535980	0.557264
67	0.562275	0.058434	68	0.578718	0.600172
68	0.606119	0.062789	69	0.621661	0.643451
69	0.649867	0.067184	70	0.665294	0.687136
70	0.694034	0.071622	71	0.709200	0.731263
71	0.738657	0.076108	72	0.753566	0.775869
72	0.783776	0.080646	73	0.798433	0.820996
73	0.829434	0.085524	74	0.843842	0.866688
74	0.875675	0.089894	75	0.888939	0.912999
75	0.922255	0.094615	76	0.933647	0.959955
76	0.970110	0.099406	77	0.983379	1.007636
77	0.018414	0.042275	78	1.031865	1.056094
78	0.067523	0.092288	79	1.080074	1.105392
79	0.117507	0.142272	80	1.130497	1.155600
80	0.168440	0.194153	81	1.181203	1.206804
81	0.220404	0.246654	82	1.233294	1.259908
82	0.273499	0.300032	83	1.285580	1.312533
83	0.327800	0.355279	84	1.339989	1.366726
84	0.383454	0.411629	85	1.395533	1.422330
85	0.440572	0.469515	86	1.452230	1.481064
86	0.499303	0.529091	87	1.510743	1.540422
87	0.559811	0.590532	88	1.571034	1.601647
88	0.622288	0.654044	89	1.633294	1.664941
89	0.686952	0.719860	90	1.697741	1.730540
90	0.754059	0.788259	91	1.764630	1.798721
91	0.823391	0.859566	92	1.834264	1.866980
92	0.896669	0.934172	93	1.907001	1.944193
93	0.973361	0.012550	94	1.983270	2.022347
94	0.053915	0.095281	95	2.063599	2.104851
95	0.139185	0.183089	96	2.148640	2.192428
96	0.229933	0.276896	97	2.233921	2.285999
97	0.327399	0.377902	98	2.336380	2.386761
98	0.432806	0.487710	99	2.441539	2.496317
99	0.548124	0.608538	100	2.556600	2.616882
100	0.676061	0.743583	101	2.684265	2.751648
101	0.820650	0.897717	102	2.828566	2.905483
102	0.988328	0.078940	103	2.995931	3.086378
103	3.190416	3.301891	104	3.197667	3.308957
104	3.450169	3.598447	105	3.457009	3.605061
105	3.832147	4.065848	106	3.838448	4.071836
ERROR = 0.000242			ERROR = 0.000238		
ENTROPY = 6.416172			ENTROPY = 6.429724		

TABLE I
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 107			N = 108		
J	X	Y	J	X	Y
54	0.0201103	0.0000000	55	0.0000000	0.0199917
55	0.0201103	0.0040205	56	0.0039839	0.0599761
56	0.0600319	0.0080432	57	0.0079699	0.0999637
57	0.1000568	0.0120703	58	0.0119601	0.1399566
58	0.1400871	0.0161039	59	0.0159567	0.1799569
59	0.1812251	0.0201462	60	0.0199619	0.2199668
60	0.2217299	0.0241996	61	0.0239777	0.2599885
61	0.2623229	0.0282662	62	0.0280064	0.3000243
62	0.3030744	0.0323488	63	0.0320504	0.3400765
63	0.3439987	0.0364488	64	0.0361119	0.3814774
64	0.3850093	0.0405697	65	0.0401934	0.4222394
65	0.4264117	0.0447137	66	0.0442973	0.4633552
66	0.4679988	0.0488834	67	0.0484263	0.5049774
67	0.5099825	0.0530081	68	0.0525883	0.5466866
68	0.5519665	0.0571313	69	0.0567702	0.5888718
69	0.5944434	0.0615754	70	0.0609908	0.6310998
70	0.6372263	0.0658772	71	0.0652488	0.6738662
71	0.6804886	0.0702200	72	0.0695453	0.7170339
72	0.7241337	0.0746074	73	0.0738853	0.7606667
73	0.7682553	0.0790432	74	0.0782725	0.8047883
74	0.8128874	0.0835315	75	0.0827105	0.8494227
75	0.8580041	0.0880766	76	0.0872033	0.8946443
76	0.9037999	0.0926832	77	0.0917560	0.9404777
77	0.9501997	0.0973562	78	0.0963728	0.9869779
78	0.9972288	0.1021013	79	0.1010591	1.0342204
79	1.0451233	0.1069242	80	0.1058207	1.0822100
80	1.0933779	0.1118331	81	0.1106636	1.1310263
81	1.1433309	0.1168303	82	0.1155947	1.1808332
82	1.1939333	0.1219283	83	0.1206214	1.2315996
83	1.2453113	0.1271343	84	0.1257518	1.2834440
84	1.2979559	0.1324576	85	0.1309951	1.3363616
85	1.3518334	0.1379092	86	0.1363613	1.3900765
86	1.4070500	0.1435009	87	0.1418618	1.4446471
87	1.4637336	0.1492463	88	0.1475094	1.5003716
88	1.5220335	0.1551608	89	0.1533184	1.5572652
89	1.5821114	0.1612620	90	0.1593053	1.6162345
90	1.6441600	0.1675701	91	0.1654899	1.6783627
91	1.7083394	0.1741087	92	0.1718999	1.7435503
92	1.7750707	0.1809053	93	0.1785381	1.8119259
93	1.8444489	0.1879925	94	0.1854589	1.8839999
94	1.9170000	0.1954092	95	0.1926896	1.9593873
95	1.9933060	0.2032207	96	0.2002732	2.0415611
96	2.0733167	0.2114307	97	0.2082621	2.1236552
97	2.1579882	0.2201657	98	0.2167215	2.2107788
98	2.2483226	0.2294995	99	0.2257332	2.3038866
99	2.3452556	0.2395518	100	0.2354030	2.4041774
100	2.4501722	0.2504326	101	0.2458705	2.5133237
101	2.5649778	0.2625131	102	0.2573262	2.6332886
102	2.6923377	0.2759623	103	0.2700397	2.7675008
103	2.8363393	0.2913163	104	0.2844133	2.9207599
104	3.0034449	0.3093734	105	0.3010885	3.1010111
105	3.2048400	0.3315946	106	0.3211935	3.3228559
106	3.4637775	0.3611605	107	0.3470470	3.6180880
107	3.8446883	0.4077761	108	0.3850853	4.0836225
ERROR = 0.000233			ERROR = 0.000229		
ENTROPY = 6.443151			ENTROPY = 6.456453		

TABLE I
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 109			N = 110		
J	X	Y	J	X	Y
55	0.019737	0.000000	56	0.000000	0.019558
56	0.019737	0.003947	57	0.003912	0.038684
57	0.059922	0.078996	58	0.078261	0.097839
58	0.098736	0.118504	59	0.117442	0.137045
59	0.138303	0.158102	60	0.156683	0.176321
60	0.177942	0.197782	61	0.196005	0.215688
61	0.217674	0.237566	62	0.235428	0.255167
62	0.257522	0.277477	63	0.274973	0.294779
63	0.297506	0.317535	64	0.314662	0.334545
64	0.337649	0.357763	65	0.354517	0.374489
65	0.377975	0.398186	66	0.394561	0.414633
66	0.418506	0.438827	67	0.434817	0.455001
67	0.459226	0.479910	68	0.475309	0.495618
68	0.500287	0.520863	69	0.516053	0.536509
69	0.541587	0.562312	70	0.557105	0.577701
70	0.583199	0.604085	71	0.598846	0.619222
71	0.625149	0.646213	72	0.640716	0.661103
72	0.667470	0.688727	73	0.682223	0.703374
73	0.710193	0.731660	74	0.724721	0.746068
74	0.753353	0.775047	75	0.767644	0.789220
75	0.796987	0.818926	76	0.811104	0.832868
76	0.841113	0.863337	77	0.855495	0.877051
77	0.885883	0.908323	78	0.899943	0.921822
78	0.931127	0.953930	79	0.944505	0.967198
79	0.977070	1.000209	80	0.990228	1.013258
80	1.023711	1.047213	81	1.036652	1.060443
81	1.071107	1.095001	82	1.083333	1.107800
82	1.119319	1.143638	83	1.131833	1.155604
83	1.168415	1.193193	84	1.180718	1.205399
84	1.218469	1.244555	85	1.230056	1.255733
85	1.269562	1.295380	86	1.281450	1.307164
86	1.321788	1.348192	87	1.333346	1.359771
87	1.375240	1.402288	88	1.385718	1.413664
88	1.430000	1.457788	89	1.444313	1.468896
89	1.486307	1.514826	90	1.499738	1.525798
90	1.544492	1.573557	91	1.555062	1.584437
91	1.603856	1.634155	92	1.611452	1.644443
92	1.665488	1.696822	93	1.670956	1.707188
93	1.729930	1.761792	94	1.733957	1.771957
94	1.795567	1.829934	95	1.800562	1.839302
95	1.864567	1.899993	96	1.877442	1.909349
96	1.936865	1.973537	97	1.946631	1.983086
97	2.012289	2.051042	98	2.021733	2.060323
98	2.091899	2.132887	99	2.101199	2.142015
99	2.176340	2.219793	100	2.185360	2.228704
100	2.266234	2.312676	101	2.275035	2.321366
101	2.362704	2.412731	102	2.371279	2.421192
102	2.467142	2.521554	103	2.475485	2.529778
103	2.581452	2.641351	104	2.589552	2.649327
104	2.708832	2.775307	105	2.716174	2.783302
105	2.851789	2.928271	106	2.859361	2.935702
106	3.018240	3.108209	107	3.025516	3.115330
107	3.218954	3.329700	108	3.225899	3.336468
108	3.477709	3.624488	109	3.483648	3.630829
109	3.856958	4.089429	110	3.863002	4.095175
ERROR = 0.000225			ERROR = 0.000221		
ENTROPY = 6.469634			ENTROPY = 6.482696		

TABLE 1
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 111			N = 112		
J	X	Y	J	X	Y
56	0.0101935	0.00000	57	0.00000	0.00000
57	0.00000	0.00000	58	0.00000	0.00000
58	0.00000	0.00000	59	0.00000	0.00000
59	0.00000	0.00000	60	0.00000	0.00000
60	0.00000	0.00000	61	0.00000	0.00000
61	0.00000	0.00000	62	0.00000	0.00000
62	0.00000	0.00000	63	0.00000	0.00000
63	0.00000	0.00000	64	0.00000	0.00000
64	0.00000	0.00000	65	0.00000	0.00000
65	0.00000	0.00000	66	0.00000	0.00000
66	0.00000	0.00000	67	0.00000	0.00000
67	0.00000	0.00000	68	0.00000	0.00000
68	0.00000	0.00000	69	0.00000	0.00000
69	0.00000	0.00000	70	0.00000	0.00000
70	0.00000	0.00000	71	0.00000	0.00000
71	0.00000	0.00000	72	0.00000	0.00000
72	0.00000	0.00000	73	0.00000	0.00000
73	0.00000	0.00000	74	0.00000	0.00000
74	0.00000	0.00000	75	0.00000	0.00000
75	0.00000	0.00000	76	0.00000	0.00000
76	0.00000	0.00000	77	0.00000	0.00000
77	0.00000	0.00000	78	0.00000	0.00000
78	0.00000	0.00000	79	0.00000	0.00000
79	0.00000	0.00000	80	0.00000	0.00000
80	0.00000	0.00000	81	0.00000	0.00000
81	0.00000	0.00000	82	0.00000	0.00000
82	0.00000	0.00000	83	0.00000	0.00000
83	0.00000	0.00000	84	0.00000	0.00000
84	0.00000	0.00000	85	0.00000	0.00000
85	0.00000	0.00000	86	0.00000	0.00000
86	0.00000	0.00000	87	0.00000	0.00000
87	0.00000	0.00000	88	0.00000	0.00000
88	0.00000	0.00000	89	0.00000	0.00000
89	0.00000	0.00000	90	0.00000	0.00000
90	0.00000	0.00000	91	0.00000	0.00000
91	0.00000	0.00000	92	0.00000	0.00000
92	0.00000	0.00000	93	0.00000	0.00000
93	0.00000	0.00000	94	0.00000	0.00000
94	0.00000	0.00000	95	0.00000	0.00000
95	0.00000	0.00000	96	0.00000	0.00000
96	0.00000	0.00000	97	0.00000	0.00000
97	0.00000	0.00000	98	0.00000	0.00000
98	0.00000	0.00000	99	0.00000	0.00000
99	0.00000	0.00000	100	0.00000	0.00000
100	0.00000	0.00000	101	0.00000	0.00000
101	0.00000	0.00000	102	0.00000	0.00000
102	0.00000	0.00000	103	0.00000	0.00000
103	0.00000	0.00000	104	0.00000	0.00000
104	0.00000	0.00000	105	0.00000	0.00000
105	0.00000	0.00000	106	0.00000	0.00000
106	0.00000	0.00000	107	0.00000	0.00000
107	0.00000	0.00000	108	0.00000	0.00000
108	0.00000	0.00000	109	0.00000	0.00000
109	0.00000	0.00000	110	0.00000	0.00000
110	0.00000	0.00000	111	0.00000	0.00000
111	0.00000	0.00000	112	0.00000	0.00000
ERROR = 0.000217			ERROR = 0.000213		
ENTROPY = 6.495640			ENTROPY = 6.508469		

TABLE I
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 113			N = 114		
J	X	Y	J	X	Y
57	-0.019044	0.000000	58	-0.000001	0.018876
58	0.019044	0.003800	59	0.003775	0.056640
59	0.057714	0.076619	60	0.075535	0.094443
60	0.095526	0.114333	61	0.113334	0.132266
61	0.133344	0.152253	62	0.151216	0.170165
62	0.171111	0.190081	63	0.189155	0.208146
63	0.209999	0.227911	64	0.227186	0.246227
64	0.248841	0.265765	65	0.265327	0.284427
65	0.287666	0.303627	66	0.303597	0.322766
66	0.326555	0.341503	67	0.342015	0.361264
67	0.365444	0.379399	68	0.380603	0.399994
68	0.404333	0.417311	69	0.419381	0.438882
69	0.443222	0.455246	70	0.458170	0.477799
70	0.482111	0.493200	71	0.496959	0.516726
71	0.521000	0.531171	72	0.535747	0.555679
72	0.559889	0.569161	73	0.574633	0.594678
73	0.598778	0.607171	74	0.613520	0.633714
74	0.637667	0.645200	75	0.652401	0.672787
75	0.676556	0.683255	76	0.691280	0.711853
76	0.715444	0.721333	77	0.730167	0.750991
77	0.734333	0.739444	78	0.749055	0.789993
78	0.753222	0.757555	79	0.767944	0.828888
79	0.772111	0.775666	80	0.786833	0.867777
80	0.791000	0.794777	81	0.805722	0.906666
81	0.809889	0.813889	82	0.824611	0.945555
82	0.828778	0.832999	83	0.843500	0.984444
83	0.847667	0.852111	84	0.862389	1.023333
84	0.866556	0.871222	85	0.881278	1.062222
85	0.885444	0.890333	86	0.900167	1.101111
86	0.904333	0.909444	87	0.919056	1.140000
87	0.923222	0.928555	88	0.937944	1.178889
88	0.942111	0.947666	89	0.956833	1.217778
89	0.961000	0.966777	90	0.975722	1.256667
90	0.979889	0.985889	91	0.994611	1.295556
91	0.998778	1.004999	92	1.013500	1.334444
92	1.017667	1.024111	93	1.032389	1.373333
93	1.036556	1.043222	94	1.051278	1.412222
94	1.055444	1.062333	95	1.070167	1.451111
95	1.074333	1.081444	96	1.089056	1.490000
96	1.093222	1.100555	97	1.107944	1.528889
97	1.112111	1.119666	98	1.126833	1.567778
98	1.131000	1.138777	99	1.145722	1.606667
99	1.149889	1.157889	100	1.164611	1.645556
100	1.168778	1.176999	101	1.183500	1.684444
101	1.187667	1.196111	102	1.202389	1.723333
102	1.206556	1.215222	103	1.221278	1.762222
103	1.225444	1.234333	104	1.240167	1.801111
104	1.244333	1.253444	105	1.259056	1.840000
105	1.263222	1.272555	106	1.277944	1.878889
106	1.282111	1.291666	107	1.296833	1.917778
107	1.301000	1.310777	108	1.315722	1.956667
108	1.319889	1.329889	109	1.334611	1.995556
109	1.338778	1.348999	110	1.353500	2.034444
110	1.357667	1.368111	111	1.372389	2.073333
111	1.376556	1.387222	112	1.391278	2.112222
112	1.395444	1.406333	113	1.410167	2.151111
113	1.414333	1.425444	114	1.429056	2.190000
ERROR = 0.000209			ERROR = 0.000206		
ENTROPY = 6.521185			ENTROPY = 6.533790		

TABLE I
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 115			N = 116		
J	X	Y	J	X	Y
59	0.0018716	0.0000000	59	0.0000000	0.0185555
60	0.0018871	0.0037431	60	0.0037113	0.0556772
61	0.0056615	0.0748880	61	0.0742444	0.0928166
62	0.0093362	0.1123664	62	0.1114009	0.1300002
63	0.0131132	0.1499001	63	0.1486625	0.1677248
64	0.0168704	0.1875008	64	0.1859100	0.2045711
65	0.0206356	0.2252004	65	0.2233281	0.2419900
66	0.0244105	0.2630007	66	0.2607566	0.2795222
67	0.0281971	0.3009355	67	0.2983354	0.3171886
68	0.0319972	0.3390008	68	0.3360933	0.3550000
69	0.0358112	0.3772466	69	0.3739933	0.3929985
70	0.0396398	0.4156699	70	0.4120772	0.4311159
71	0.0434833	0.4542997	71	0.4503552	0.4695544
72	0.0473417	0.4931553	72	0.4888553	0.5081662
73	0.0512150	0.5322588	73	0.5275997	0.5470333
74	0.0551031	0.5716337	74	0.5666607	0.5861882
75	0.0590060	0.6113133	75	0.6059907	0.6255633
76	0.0629247	0.6513133	76	0.6455521	0.6651444
77	0.0668591	0.6916633	77	0.6854776	0.7050555
78	0.0708092	0.7323393	78	0.7257999	0.7452222
79	0.0747750	0.7733533	79	0.7665200	0.7856999
80	0.0787564	0.8147111	80	0.8076699	0.8263999
81	0.0827533	0.8564111	81	0.8491927	0.8673000
82	0.0867657	0.8984555	82	0.8911388	0.9084444
83	0.0907936	0.9408444	83	0.9334022	0.9497777
84	0.0948370	0.9835777	84	0.9760777	0.9913000
85	0.0988959	1.0266666	85	1.0191111	1.0330000
86	0.1029693	1.0701111	86	1.0625555	1.0749999
87	0.1070572	1.1139111	87	1.1063333	1.1172222
88	0.1111596	1.1580666	88	1.1504444	1.1597777
89	0.1152765	1.2025777	89	1.1949777	1.2026666
90	0.1194079	1.2474444	90	1.2399333	1.2458888
91	0.1235538	1.2926666	91	1.2853333	1.2894444
92	0.1277152	1.3382555	92	1.3311666	1.3333333
93	0.1318921	1.3842111	93	1.3774444	1.3775555
94	0.1360845	1.4305333	94	1.4241666	1.4222222
95	0.1402924	1.4772222	95	1.4713333	1.4673333
96	0.1445158	1.5242777	96	1.5189444	1.5128888
97	0.1487547	1.5717000	97	1.5670000	1.5588888
98	0.1530091	1.6194888	98	1.6155000	1.6052222
99	0.1572790	1.6676444	99	1.6644444	1.6519999
100	0.1615644	1.7161666	100	1.7137777	1.6991111
101	0.1658653	1.7650555	101	1.7635555	1.7466666
102	0.1701817	1.8143111	102	1.8137777	1.7944444
103	0.1745136	1.8639444	103	1.8644444	1.8426666
104	0.1788609	1.9139555	104	1.9155555	1.8913333
105	0.1832236	1.9643333	105	1.9670000	1.9404444
106	0.1876017	2.0150666	106	2.0188888	1.9899999
107	0.1919952	2.0661666	107	2.0711111	2.0399999
108	0.1964041	2.1176222	108	2.1237777	2.0904444
109	0.2008284	2.1694444	109	2.1767777	2.1413333
110	0.2052681	2.2216222	110	2.2301111	2.1926666
111	0.2097232	2.2741666	111	2.2837777	2.2444444
112	0.2141937	2.3270777	112	2.3377777	2.2966666
113	0.2186796	2.3803555	113	2.3921111	2.3494444
114	0.2231809	2.4340000	114	2.4468888	2.4027777
115	0.2276976	2.4880111	115	2.5020000	2.4566666
116	0.2322297	2.5423888	116	2.5574444	2.5111111
ERROR = 0.000202			ERROR = 0.000199		
ENTROPY = 6.546286			ENTROPY = 6.558674		

TABLE 1
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 117			N = 118		
J	X	Y	J	X	Y
59	0.0183398	0.0000000	60	0.0000000	0.018243
60	0.0183398	0.0036797	61	0.0364899	0.0547336
61	0.0552033	0.0736110	62	0.0729995	0.0912554
62	0.0922033	0.110457	63	0.1095333	0.127812
63	0.1289905	0.1473553	64	0.146120	0.164428
64	0.1658355	0.184317	65	0.1827722	0.201117
65	0.2028441	0.221365	66	0.219506	0.237896
66	0.2399514	0.2585114	67	0.2563340	0.274783
67	0.2771149	0.2957833	68	0.2932899	0.311796
68	0.3144866	0.333189	69	0.3303733	0.348895
69	0.3519900	0.3707511	70	0.3676099	0.386267
70	0.3896422	0.408489	71	0.4050015	0.4233764
71	0.4277744	0.4464211	72	0.442612	0.461460
72	0.4655495	0.4845569	73	0.4800418	0.4999376
73	0.5033766	0.5229953	74	0.518454	0.5375333
74	0.5412274	0.5615996	75	0.5566743	0.5759553
75	0.5791005	0.6000520	76	0.5953059	0.6146558
76	0.6162013	0.6399750	77	0.6334165	0.6533672
77	0.6559531	0.6793111	78	0.6733347	0.6933021
78	0.699271	0.7192330	79	0.7128777	0.7322732
79	0.7393828	0.7595334	80	0.752781	0.772831
80	0.7798888	0.8000254	81	0.7933089	0.8133348
81	0.8200838	0.8414222	82	0.8338332	0.8543316
82	0.8602244	0.8833070	83	0.8750042	0.8955767
83	0.8999222	0.9252335	84	0.916753	0.9377338
84	0.9399655	0.9679956	85	0.9599003	0.9802677
85	0.9799655	1.0112374	86	1.0001831	1.0223395
86	1.0199655	1.0552333	87	1.0452282	1.0677169
87	1.0599655	1.0999884	88	1.0894000	1.1116333
88	1.0999655	1.145277	89	1.1342337	1.1568842
89	1.1399655	1.191472	90	1.179848	1.2028544
90	1.1799655	1.238529	91	1.2262933	1.2497331
91	1.2199655	1.286519	92	1.2736337	1.297542
92	1.2599655	1.335518	93	1.321952	1.3463633
93	1.2999655	1.385609	94	1.3713220	1.3962277
94	1.3399655	1.436888	95	1.4218228	1.4473779
95	1.3799655	1.489457	96	1.4733575	1.4999772
96	1.4199655	1.543436	97	1.5266674	1.5533575
97	1.4599655	1.5988956	98	1.5812248	1.6089221
98	1.4999655	1.6556171	99	1.6374411	1.6655960
99	1.5399655	1.7135252	100	1.6954113	1.7248666
100	1.5799655	1.7726399	101	1.7553351	1.7853377
101	1.6199655	1.8339844	102	1.817471	1.849105
102	1.6599655	1.8972858	103	1.8820223	1.914941
103	1.6999655	1.964763	104	1.9493304	1.983667
104	1.7399655	2.036944	105	2.0196666	2.0556666
105	1.7799655	2.1122866	106	2.0935335	2.131403
106	1.8199655	2.1909102	107	2.1714227	2.211451
107	1.8599655	2.2728264	108	2.2539886	2.296522
108	1.8999655	2.359563	109	2.3420223	2.3875224
109	1.9399655	2.4517882	110	2.436582	2.4856399
110	1.9799655	2.550902	111	2.5390444	2.592448
111	2.0199655	2.6570281	112	2.651292	2.7101366
112	2.0599655	2.7702811	113	2.7759997	2.841858
113	2.0999655	2.8934767	114	2.917137	2.992417
114	2.1399655	3.0285580	115	3.081064	3.1699710
115	2.1799655	3.163151	116	3.278947	3.388185
116	2.2199655	3.3081945	117	3.533750	3.679315
117	2.2599655	3.46328	118	3.909234	4.139152
ERROR = 0.000195			ERROR = 0.000192		
ENTROPY = 6.570957			ENTROPY = 6.583136		

TABLE 1

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 119			N = 120		
J	X	Y	J	X	Y
60	-0.018092	0.000000	61	0.000000	0.017941
61	0.018092	0.003618	62	0.035886	0.053831
62	0.054283	0.072382	63	0.071787	0.089744
63	0.090497	0.108613	64	0.107720	0.125695
64	0.126752	0.144891	65	0.143698	0.161701
65	0.163062	0.181233	66	0.179733	0.197777
66	0.199444	0.217655	67	0.215858	0.233939
67	0.235914	0.254173	68	0.252071	0.270203
68	0.272489	0.290805	69	0.288395	0.306586
69	0.309186	0.327567	70	0.324845	0.343105
70	0.346022	0.364478	71	0.361441	0.379777
71	0.383016	0.401554	72	0.398198	0.416620
72	0.420185	0.438816	73	0.435136	0.453632
73	0.455754	0.476282	74	0.472273	0.490893
74	0.495127	0.513972	75	0.509628	0.528363
75	0.532940	0.551907	76	0.547222	0.566081
76	0.571108	0.590109	77	0.585575	0.604070
77	0.609935	0.628600	78	0.623221	0.642235
78	0.648800	0.667404	79	0.661655	0.680499
79	0.688697	0.706546	80	0.700419	0.719888
80	0.728629	0.746052	81	0.739542	0.759895
81	0.768600	0.785950	82	0.779045	0.799889
82	0.808611	0.826269	83	0.818959	0.839902
83	0.848665	0.867042	84	0.859312	0.879903
84	0.888877	0.908300	85	0.900138	0.920673
85	0.929191	0.950081	86	0.941470	0.962267
86	0.969739	0.993322	87	0.983345	1.004424
87	1.010455	1.038953	88	1.025580	1.047184
88	1.051599	1.085953	89	1.068888	1.090559
89	1.101094	1.123236	90	1.112644	1.134666
90	1.145750	1.168265	91	1.157123	1.179949
91	1.191118	1.211409	92	1.202378	1.225207
92	1.233774	1.260798	93	1.248469	1.271732
93	1.283846	1.308433	94	1.295546	1.319194
94	1.333327	1.357078	95	1.343431	1.367668
95	1.383319	1.406918	96	1.392452	1.417237
96	1.433322	1.457747	97	1.442616	1.467795
97	1.483333	1.509968	98	1.494020	1.519466
98	1.533367	1.563588	99	1.546776	1.573507
99	1.583399	1.618772	100	1.601009	1.628851
100	1.633442	1.675539	101	1.656860	1.685520
101	1.705000	1.734371	102	1.714490	1.737772
102	1.764777	1.795169	103	1.774085	1.780439
103	1.822671	1.858823	104	1.835860	1.886722
104	1.889910	1.926444	105	1.900066	1.933200
105	1.955819	1.998997	106	1.966699	1.980111
106	2.020833	2.064473	107	2.037006	2.027499
107	2.085999	2.133949	108	2.110517	2.143800
108	2.151178	2.207112	109	2.188045	2.227688
109	2.226215	2.284594	110	2.270233	2.311533
110	2.304499	2.365402	111	2.357839	2.403196
111	2.344433	2.493317	112	2.452056	2.500099
112	2.546617	2.599917	113	2.554113	2.600791
113	2.658852	2.717387	114	2.665937	2.724564
114	2.783132	2.848876	115	2.790195	2.855825
115	2.928031	2.999187	116	2.930857	3.005889
116	3.088695	3.176204	117	3.094262	3.182634
117	3.288529	3.394365	118	3.291559	3.400485
118	3.539739	3.685113	119	3.545671	3.690856
119	3.914764	4.144416	120	3.920244	4.149631
ERROR = 0.000189			ERROR = 0.000186		
ENTROPY = 6.595213			ENTROPY = 6.607190		

TABLE 1

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 121			N = 122		
J	X	Y	J	X	Y
61	0.0177795	0.0000000	62	0.0000000	0.0176449
62	0.0177795	0.0355900	63	0.0353020	0.0529555
63	0.0533392	0.0711955	64	0.0706199	0.0882833
64	0.0890112	0.1068300	65	0.1059665	0.1236488
65	0.1246700	0.1425100	66	0.1413556	0.1590664
66	0.1603800	0.1782510	67	0.1768005	0.1945477
67	0.1961599	0.2140667	68	0.2123229	0.2300111
68	0.2320222	0.2499976	69	0.2479433	0.2655774
69	0.2679844	0.2859993	70	0.2836661	0.3015499
70	0.3040663	0.3222133	71	0.3195001	0.3374533
71	0.3402774	0.3584155	72	0.3554788	0.3735033
72	0.3766334	0.3948854	73	0.3916009	0.4097155
73	0.4131611	0.4314699	74	0.4279111	0.4461007
74	0.4498873	0.4682278	75	0.4644002	0.4822698
75	0.4867788	0.5052299	76	0.5011101	0.5195055
76	0.5239226	0.5425533	77	0.5380266	0.5566548
77	0.5613300	0.5800059	78	0.5751988	0.5938447
78	0.5989950	0.6178400	79	0.6126336	0.6314224
79	0.6368788	0.6559177	80	0.6503633	0.6693301
80	0.6751115	0.6943313	81	0.6884401	0.7075000
81	0.7136884	0.7330054	82	0.7267774	0.7460047
82	0.7526100	0.7721655	83	0.7655007	0.7849367
83	0.7919220	0.8116774	84	0.8046227	0.8242997
84	0.8316422	0.8516100	85	0.8441622	0.8644037
85	0.8718007	0.8920003	86	0.8841442	0.9042247
86	0.9124446	0.9322888	87	0.9245999	0.9445951
87	0.9535944	0.9743000	88	0.9655567	0.9866193
88	0.9952668	1.0162276	89	1.0007082	1.0277692
89	1.0375666	1.0588357	90	1.0491855	1.0700338
90	1.0804733	1.1020089	91	1.0991917	1.1133446
91	1.1240053	1.1460018	92	1.1353224	1.1572003
92	1.1683357	1.1906997	93	1.1794557	1.2017711
93	1.2134339	1.236182	94	1.224370	1.2470288
94	1.2593360	1.2825337	95	1.270121	1.2933215
95	1.3061833	1.3298299	96	1.316777	1.3403340
96	1.3539931	1.3781333	97	1.3644009	1.3884788
97	1.4028834	1.4275335	98	1.4130096	1.4377714
98	1.4528830	1.4778122	99	1.462927	1.4888140
99	1.5040667	1.5300009	100	1.5140000	1.5399960
100	1.5566557	1.5833304	101	1.5664226	1.5929911
101	1.6107223	1.6388141	102	1.6203228	1.6476655
102	1.6664007	1.694672	103	1.6758448	1.7040031
103	1.7233870	1.7530063	104	1.7333147	1.7622263
104	1.7832998	1.8135227	105	1.792410	1.8222557
105	1.8444904	1.8762231	106	1.8533851	1.8855145
106	1.9083941	1.9416000	107	1.9177720	1.9500066
107	1.9757701	2.0098503	108	1.984313	2.0183300
108	2.0455338	2.0812733	109	2.053979	2.0893628
109	2.1188733	2.156473	110	2.127142	2.1646958
110	2.1962224	2.2359974	111	2.204317	2.2433979
111	2.2782330	2.320486	112	2.286144	2.3283310
112	2.3655700	2.4109914	113	2.373431	2.4185552
113	2.459675	2.508436	114	2.467217	2.515882
114	2.561532	2.6146299	115	2.568878	2.621874
115	2.673150	2.731670	116	2.680290	2.738706
116	2.797188	2.862705	117	2.804112	2.869518
117	2.937616	3.012526	118	2.944308	3.019098
118	3.100764	3.189003	119	3.107204	3.195310
119	3.297775	3.406547	120	3.303931	3.412551
120	3.551546	3.696545	121	3.557366	3.702182
121	3.925672	4.154798	122	3.931050	4.159918
ERROR = 0.000183			ERROR = 0.000180		
ENTROPY = 6.619068			ENTROPY = 6.630849		

TABLE 1
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 123			N = 124		
J	X	Y	J	X	Y
62	0.017508	0.000000	63	0.000000	0.017367
63	0.017508	0.035015	64	0.034737	0.052107
64	0.052530	0.070045	65	0.069488	0.086869
65	0.087575	0.105104	66	0.104267	0.121665
66	0.122655	0.140206	67	0.139088	0.156511
67	0.157785	0.175365	68	0.173996	0.191420
68	0.192981	0.210597	69	0.208914	0.226408
69	0.228256	0.245916	70	0.243347	0.261487
70	0.263362	0.281338	71	0.279081	0.296675
71	0.299108	0.316877	72	0.314333	0.331990
72	0.334471	0.352551	73	0.339597	0.367444
73	0.370046	0.388375	74	0.384833	0.403000
74	0.406333	0.424411	75	0.420055	0.438677
75	0.442445	0.460541	76	0.455225	0.474499
76	0.478822	0.496991	77	0.490395	0.510477
77	0.515511	0.533751	78	0.525514	0.546611
78	0.552551	0.570833	79	0.560611	0.582900
79	0.589911	0.608250	80	0.595661	0.619400
80	0.627661	0.646009	81	0.630711	0.656111
81	0.665881	0.684111	82	0.665811	0.693000
82	0.704441	0.722551	83	0.700911	0.730000
83	0.743331	0.761333	84	0.735911	0.767111
84	0.782551	0.800444	85	0.770911	0.804444
85	0.822221	0.839888	86	0.805911	0.842000
86	0.862221	0.879666	87	0.840911	0.879777
87	0.902551	0.919888	88	0.875911	0.917777
88	0.943331	0.960444	89	0.910911	0.956000
89	0.984441	1.001333	90	0.945911	0.994444
90	1.025551	1.042555	91	0.980911	1.033000
91	1.066661	1.084111	92	1.015911	1.071777
92	1.107771	1.126000	93	1.050911	1.110777
93	1.148881	1.168222	94	1.085911	1.149999
94	1.189991	1.210888	95	1.120911	1.189444
95	1.231101	1.253888	96	1.155911	1.229000
96	1.272221	1.297222	97	1.190911	1.268777
97	1.313331	1.340999	98	1.225911	1.308777
98	1.354441	1.385111	99	1.260911	1.349000
99	1.395551	1.429666	100	1.295911	1.389444
100	1.436661	1.474666	101	1.330911	1.430000
101	1.477771	1.520000	102	1.365911	1.470777
102	1.518881	1.565777	103	1.400911	1.511777
103	1.559991	1.611999	104	1.435911	1.553000
104	1.601101	1.658666	105	1.470911	1.594444
105	1.642221	1.705777	106	1.505911	1.636000
106	1.683331	1.753333	107	1.540911	1.677777
107	1.724441	1.801333	108	1.575911	1.719777
108	1.765551	1.849777	109	1.610911	1.762000
109	1.806661	1.898666	110	1.645911	1.804444
110	1.847771	1.948000	111	1.680911	1.847000
111	1.888881	1.997777	112	1.715911	1.890000
112	1.929991	2.048000	113	1.750911	1.933333
113	1.971101	2.098666	114	1.785911	1.977000
114	2.012221	2.149777	115	1.820911	2.021000
115	2.053331	2.201333	116	1.855911	2.065333
116	2.094441	2.253333	117	1.890911	2.110000
117	2.135551	2.305777	118	1.925911	2.155000
118	2.176661	2.358666	119	1.960911	2.200333
119	2.217771	2.412000	120	2.000000	2.246000
120	2.258881	2.465777	121	2.039090	2.292000
121	2.299991	2.520000	122	2.078181	2.338333
122	2.341101	2.574666	123	2.117272	2.385000
123	2.382221	2.629777	124	2.156363	2.432000
ERROR = 0.000177			ERROR = 0.000174		
ENTROPY = 6.642534			ENTROPY = 6.654126		

TABLE 1

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 125			N = 126		
J	X	Y	J	X	Y
63	-0.017230	0.000000	64	0.000000	0.017093
64	0.017230	0.003445	65	0.034189	0.051286
65	0.051286	0.068933	66	0.068933	0.085549
66	0.085549	0.103433	67	0.102622	0.119946
67	0.120775	0.137975	68	0.136892	0.154033
68	0.155273	0.172571	69	0.171216	0.188333
69	0.189904	0.207237	70	0.205607	0.222821
70	0.222991	0.241986	71	0.240080	0.257338
71	0.255944	0.276832	72	0.274647	0.291957
72	0.292933	0.311791	73	0.309325	0.326693
73	0.332944	0.346878	74	0.344127	0.361561
74	0.365990	0.392107	75	0.379068	0.396564
75	0.399977	0.417495	76	0.414166	0.431711
76	0.440000	0.453058	77	0.449432	0.466911
77	0.454400	0.488881	78	0.484888	0.502263
78	0.500000	0.524779	79	0.520046	0.537777
79	0.555556	0.560971	80	0.555556	0.573333
80	0.600000	0.633411	81	0.622222	0.600000
81	0.655556	0.677111	82	0.666667	0.626667
82	0.700000	0.708411	83	0.702222	0.653333
83	0.744444	0.744033	84	0.739999	0.680000
84	0.788889	0.784000	85	0.777778	0.706667
85	0.833333	0.828444	86	0.815455	0.733333
86	0.877778	0.861111	87	0.853333	0.760000
87	0.922222	0.890000	88	0.890000	0.786667
88	0.966667	0.916667	89	0.926667	0.813333
89	1.000000	0.940000	90	0.963333	0.840000
90	1.033333	0.960000	91	1.000000	0.866667
91	1.066667	0.976667	92	1.033333	0.893333
92	1.100000	0.990000	93	1.066667	0.920000
93	1.133333	1.000000	94	1.100000	0.946667
94	1.166667	1.013333	95	1.133333	0.973333
95	1.200000	1.030000	96	1.166667	1.000000
96	1.233333	1.046667	97	1.200000	1.026667
97	1.266667	1.063333	98	1.233333	1.053333
98	1.300000	1.080000	99	1.266667	1.080000
99	1.333333	1.096667	100	1.300000	1.106667
100	1.366667	1.113333	101	1.333333	1.133333
101	1.400000	1.130000	102	1.366667	1.160000
102	1.433333	1.146667	103	1.400000	1.186667
103	1.466667	1.163333	104	1.433333	1.213333
104	1.500000	1.180000	105	1.466667	1.240000
105	1.533333	1.196667	106	1.500000	1.266667
106	1.566667	1.213333	107	1.533333	1.293333
107	1.600000	1.230000	108	1.566667	1.320000
108	1.633333	1.246667	109	1.600000	1.346667
109	1.666667	1.263333	110	1.633333	1.373333
110	1.700000	1.280000	111	1.666667	1.400000
111	1.733333	1.296667	112	1.700000	1.426667
112	1.766667	1.313333	113	1.733333	1.453333
113	1.800000	1.330000	114	1.766667	1.480000
114	1.833333	1.346667	115	1.800000	1.506667
115	1.866667	1.363333	116	1.833333	1.533333
116	1.900000	1.380000	117	1.866667	1.560000
117	1.933333	1.396667	118	1.900000	1.586667
118	1.966667	1.413333	119	1.933333	1.613333
119	2.000000	1.430000	120	1.966667	1.640000
120	2.033333	1.446667	121	2.000000	1.666667
121	2.066667	1.463333	122	2.033333	1.693333
122	2.100000	1.480000	123	2.066667	1.720000
123	2.133333	1.496667	124	2.100000	1.746667
124	2.166667	1.513333	125	2.133333	1.773333
125	2.200000	1.530000	126	2.166667	1.800000
126	2.233333	1.546667			
ERROR = 0.000171			ERROR = 0.000169		
ENTROPY = 6.665625			ENTROPY = 6.677034		

TABLE 1
MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 127			N = 128		
J	X	Y	J	X	Y
64	-0.016961	0.000000	65	-0.000001	0.016828
65	0.016960	0.033921	66	0.033659	0.050490
66	0.050888	0.067855	67	0.067331	0.084172
67	0.084835	0.101815	68	0.101029	0.117886
68	0.118814	0.135814	69	0.134765	0.151644
69	0.152840	0.169865	70	0.168552	0.185460
70	0.186924	0.203983	71	0.202404	0.219347
71	0.221081	0.238180	72	0.236333	0.253318
72	0.255325	0.272470	73	0.270353	0.287387
73	0.289668	0.306867	74	0.304477	0.321567
74	0.324126	0.341385	75	0.338720	0.355874
75	0.358871	0.376040	76	0.373097	0.390320
76	0.393433	0.410845	77	0.407620	0.424921
77	0.428173	0.445818	78	0.442307	0.459693
78	0.463096	0.480973	79	0.477172	0.494651
79	0.498165	0.516328	80	0.512231	0.529812
80	0.533411	0.551699	81	0.547502	0.565192
81	0.569801	0.587704	82	0.583001	0.600810
82	0.605733	0.623376	83	0.618747	0.636684
83	0.641927	0.660093	84	0.654758	0.672833
84	0.678404	0.696716	85	0.699105	0.709277
85	0.715185	0.733654	86	0.727658	0.746039
86	0.752291	0.770928	87	0.764589	0.783139
87	0.789746	0.808563	88	0.801871	0.820602
88	0.827573	0.846658	89	0.839532	0.858454
89	0.865800	0.885016	90	0.877587	0.896671
90	0.904445	0.923389	91	0.916074	0.935343
91	0.943353	0.963355	92	0.955019	0.974609
92	0.983159	1.003083	93	0.994453	1.014296
93	1.023276	1.043470	94	1.034409	1.054523
94	1.063950	1.084431	95	1.074924	1.095326
95	1.105220	1.126009	96	1.116003	1.136747
96	1.147127	1.168246	97	1.157788	1.178828
97	1.189971	1.211189	98	1.200223	1.221617
98	1.233303	1.254890	99	1.243391	1.265165
99	1.277714	1.299404	100	1.287346	1.309527
100	1.322209	1.344794	101	1.332146	1.354766
101	1.367796	1.391127	102	1.377857	1.400948
102	1.414802	1.438478	103	1.424548	1.448148
103	1.462703	1.486692	104	1.472299	1.496450
104	1.511175	1.536571	105	1.521196	1.545943
105	1.552204	1.587509	106	1.571338	1.596733
106	1.613684	1.639859	107	1.622833	1.648933
107	1.666600	1.693751	108	1.675805	1.702677
108	1.721554	1.749333	109	1.730399	1.758111
109	1.778058	1.806781	110	1.786735	1.815407
110	1.836534	1.866287	111	1.845089	1.874762
111	1.897118	1.928081	112	1.905583	1.936404
112	1.960256	1.992431	113	1.968503	2.000601
113	2.026044	2.059656	114	2.034136	2.067671
114	2.094896	2.130135	115	2.102832	2.137993
115	2.167232	2.204329	116	2.175010	2.212027
116	2.243566	2.282804	117	2.251183	2.290339
117	2.324534	2.366265	118	2.331986	2.373634
118	2.410940	2.455614	119	2.418222	2.462811
119	2.503381	2.552021	120	2.510926	2.559040
120	2.604536	2.657052	121	2.611463	2.663886
121	2.714963	2.772874	122	2.721700	2.779514
122	2.837744	2.902614	123	2.844280	2.909047
123	2.976825	3.051036	124	2.983146	3.057246
124	3.138503	3.225970	125	3.144589	3.231933
125	3.333859	3.441749	126	3.339681	3.447430
126	3.585674	3.729599	127	3.591183	3.734936
127	3.957220	4.184840	128	3.962315	4.189694
ERROR = 0.000166			ERROR = 0.000163		
ENTROPY = 6.688352			ENTROPY = 6.699583		

APPENDIX A

PROGRAM LISTING TO SOLVE FOR LLOYD-MAX QUANTIZER PARAMETERS BY THE METHOD OF SUCCESSIVE SUBSTITUTION

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C THIS PROGRAM CALCULATES LLOYD-MAX QUANTIZER PARAMETERS BY THE METHOD
C OF SUCCESSIVE SUBSTITUTION FOR THE NORMAL DISTRIBUTION OF ZERO MEAN
C AND UNIT VARIANCE
C The INPUT TO THE PROGRAM IS
C   (1) THE NUMBER OF QUANTIZATION LEVELS      N
C   (2) THE MAXIMUM NUMBER OF ITERATIONS       M
C   (2) THE ACCURACY                           AP
C *****
      REAL*8 X(199),T(199),XX(199),TT(199),C ,DELTA,AP(199),AP
      1,ERROR,ENTROP
      INTEGER K,N,I,P,N1,N2,N3,M
      C=DSQRT(00.50D0/DATAN(1.0D0))
      DO 99 N=110,110
C *****
C INPUT THE NUMBER OF QUANTIZATION LEVELS
      N=100
      WRITE(9,65)N
      WRITE(9,66)
      WRITE(9,67)
      WRITE(9,68)
C *****
C INITIALIZATION OF THE QUANTIZER PARAMETERS
      DELTA=0.0150D0*DFLOAT(N)
      XX(1)=-10.50000D0
      TT(1)=-5.50000D0
      X(1)=XX(1)
      T(1)=TT(1)
      DO 50 L=2,N
          TT(L)=TT(L-1)-DELTA
          XX(L)=(TT(L)+TT(L-1))/2.0D0
          X(L)=XX(L)
          T(L)=TT(L)
50 CONTINUE
C *****
C BEGINNING OF THE ITERATIONS
      M = MAXIMUM NUMBER OF ITERATIONS
      M = 1050
      K=0
5      K=K+1
      IF (K .GT. M) GO TO 10
      IF (K .GT. 1) X(N)=XX(N)
      IF (K .GT. 1) T(N)=TT(N)
      TT(1)=-C*DEXP(-XX(2)*XX(2)/2.0D0)/(DERFC(-10.0D0)-
      1DERFC(XX(2)/DSQRT(2.0D0)))
      T(1)=TT(1)
      IF (N .EQ. 2) GO TO 17
      DO 15 P=2,N-1
          XX(P)=(T(P)+T(P-1))/2.0D0
          X(P)=XX(P)
          TT(P)=DEXP(-X(P)*X(P)/2.0D0)-DEXP(-X(P+1)*X(P+1)/2.0D0)
          TT(P)=TT(P)*C/(DERFC(X(P)/DSQRT(2.0D0))-DERFC(X(P+1)/DSQRT(2.0
          1 0D0)))
          T(P)=TT(P)
15 CONTINUE
17 CONTINUE
      XX(N)=(TT(N)+T(N-1))/2.0D0
      TT(N)=DEXP(-XX(N)*XX(N)/2.0D0)*C/DERFC(XX(N)/DSQRT(2.0D0))
      X(N)=XX(N)
      T(N)=TT(N)

```

```

      N2=IDINT(DFLOAT((N+2)/2))
      N1=IDINT(DFLOAT((N+1)/2))
C*****
C      CHECKING THE PRECISION OF THE SOLUTION
C      AP = REQUIRED ACCURACY
      AP=0.10D-6
      IF((MOD(N,2).EQ. 0).AND.(DABS(X(N2)).GT. AP))GO TO 5
      IF((MOD(N+1,2).EQ. 0).AND.(DABS(T(N1)).GT. AP))GO TO 5
      CONTINUE
10     CONTINUE
C*****
C      OUTPUT RESULTS
      IF (MOD(N,2).EQ. 0)N3=N2
      IF (MOD(N+1,2).EQ. 0)N3=N1
      WRITE(6,60) K
      DO 120 J=1,N3
        IF (J.EQ. 1)
1       WRITE(9,71)J, T(J)
        IF (J.GT. 1)
1       WRITE(9,61)J, X(J),T(J)
120    CONTINUE
      X(N+1)=10.0D0
      X(1)=-10.0D0
      ERROR=0.0D0
      ENTROP=0.0D0
      DO 222 I=1,N
        AP(I)=DERFC(X(I)/DSQRT(2.0D0))-DERFC(X(I+1)/DSQRT(2.0D0))
        AP(I)=AP(I)/2.0D0
        ERROR=ERROR+AP(I)*T(I)**2
        ENTROP=ENTROP-AP(I)*DLOG(AP(I))/DLOG(2.0D0)
222    CONTINUE
      ERROR=1.0D0-ERROR
      WRITE(9,66)
      WRITE(9,62) ERROR
      WRITE(9,66)
      WRITE(9,63) ENTROP
      WRITE(9,66)
      WRITE(6,72) K
      WRITE(9,90)
      WRITE(9,66)
C99    CONTINUE
65     FORMAT(3X,' N = ',I7)
66     FORMAT(3X,'-----')
67     FORMAT(3X,' J      X      Y      ')
60     FORMAT(1X,I7,8(1X,F6.4))
90     FORMAT(2X,'=====')
61     FORMAT(1X,I4, 2(2X,F9.6))
71     FORMAT(1X,I4,11X, 2(2X,F9.6))
62     FORMAT(7X,'ERROR   =', 2(1X,F9.6))
72     FORMAT(3X,'# ITERATIONS = ',I7)
63     FORMAT(7X,'ENTROPY =', 2(1X,F9.6))
      STOP
      END

```

REFERENCES

1. Lloyd, S. P., "Least Squares Quantization in PCM," Unpublished Bell Laboratories manuscript, July 31, 1957; also in *IEEE Trans. on Inform. Theory*, vol. IT-28, pp. 129-137, 1982.
2. Max,J., "Quantization for Minimum Distortion", *IRE Trans. on Inform. Theory*, vol. IT-6,pp. 7-13,1960.
3. Pearson ,C. E.,Numerical Methods in Engineering and Science, pp.11-12 and 49-50, Van Nostrand Reinhold Company, New York, 1986.
4. Kassam, S. A., "Optimal Quantization for Signal Detection", *IEEE, Trans. on Communication*, vol. COM-25, No. 5,May 1977,pp. 479-484.
5. Al-Bassiouni, A.M.. *Optimum Signal Processing in Distributed Sensor Systems*, Ph. D. Dissertation at the Naval Postgraduate School, Dec. 1987.
6. Wood. C. R., "On Optimum Quantization", *IEEE Trans. on Information Theory*, vol. IT-15, No.2, March 1969.
7. Velichkin, A. I., "Optimum Characteristics of Quantizers," *Telecommunication Radio Eng. (USSR)*, vol. 18, Feb. 1963, pp.1-7.
8. Garmash,V. A., "The Quantization of Signals with Non-uniform Steps." *Telecommunications*. No. 10, pp. 10-12, Oct., 1957.

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